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SEVENTEENTH ANNUAL REPORT
OF THE
CORNELL UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
FOR THE YEAR
1904.
ITHACA, N. Y.

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SEVENTEENTH ANNUAL REPORT

OF THE

CORNELL UNIVERSITY

Agricultural Experiment Station

ITHACA, N. Y.

1904

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PUBLISHED BY THE UNIVERSITY
ITHACA, N. Y.
1904

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OF THE CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION.

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JAMES A. BIZZELL, Chemistry.
JOHN M. TRUEMAN, Animal Husbandry and Dairy Industry.
CHARLES E. HUNN, Horticulture.

Office of the Director, 17 Morrill Hall.

The regular bulletins of the Station are sent free to persons residing in New York State who request them.

November 30, 1904.

To His Excellency, the Governor of the State of New York,
Albany, N. Y.
To the Honorable, the Secretary of the Treasury,
Washington, D. C.
To the Honorable, the Secretary of Agriculture,
Washington, D. C.
To the Honorable, the Commissioner of Agriculture,
Albany, N. Y.

SIR :—

I have the honor to transmit herewith the seventeenth annual report of the Agricultural Experiment Station of Cornell University, in accordance with the Act of Congress of March 2, 1887, establishing the Station.

This document contains the report of the Director and the special reports of his several scientific coadjutors, as well as copies of the bulletins, Nos. 212–221, special press bulletins, Nos. 1–3, and nine special agricultural circulars, together with an itemized statement of the receipts and expenditures.

The body of this report is arranged under eleven separate headings representing the various departments under which the work of the Station is carried on, and wherever necessary each department is further subdivided to show precisely the work which is being done under the Federal Fund for Experiment and Research and the State Fund for Extension Teaching in Agriculture, respectively.

I. The Department of Agronomy is conducting experiments with the Federal Fund in seventeen rather distinct lines. A number of them bear more or less directly upon two of the larger problems in New York agriculture : viz., (1) the improvement of meadows and pastures ; (2) the production of easily digested foods of proper composition to take the place of grains and other concentrated food products now purchased so largely by the New York farmer. The Extension Work of this Department consists of coöperative field experiments, under the personal supervision of a member of the Department, by farmers of the State with alfalfa, oats, potatoes, field beans, soy beans, buckwheat, winter vetch and rye, sunflower in maize for silage, experiments in the destruction of weeds by spraying with chemical solutions, the inoculation of legumes, testing the effect of lime on soils, and coöperative work in plant selection and breeding.

II. In the Department of Animal Husbandry the Federal Experiment Station work has consisted of investigations concerning the utilization of skimmed milk for pigs, the possibility of increasing the percentage of fat in the milk of poorly fed cows, the economic production of beef in New York State, and the development of the early lamb industry. The Extension Work

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in Animal Husbandry, aside from lectures and instruction, has followed two general lines: (1) The supervision of the records of the production of cows for the individual owners. A great deal of such work has been done, a large part of the cost of which has been borne by the owners of the cows. (2) General investigations concerning the development of the poultry industry in the State. These have been conducted both at the University and in some of the larger private poultry establishments.

III. The principal features of the work in the Department of Horticulture under the Experiment Station Fund were (a) an investigation of orchard conditions in Wayne and Orleans counties, (b) a study of winter injury of fruit trees, (c) the influence of shade upon vegetables, (d) experiments in the forcing of vegetables, (e) experiments with insecticides and fungicides. The Extension Work has fallen into two categories: that which is instructional in character, and that which is investigational and demonstrative. The horticulturist has addressed a large number of farmers' and fruit-growers' meetings; he has inspected fruit plantations and given advice regarding their management, and has conducted a large volume of correspondence on these and allied matters in the line of investigations under Extension funds. A comprehensive series of coöperative experiments in orchard, vegetable, and flower garden are under way. These are, to a considerable extent, carried on through the coöperation of the Agricultural Experimenters' League, the Volunteer Orchard Movement, and the Western New York Horticultural Society. Enterprises of this kind are invaluable in correlating the work of the Experiment Station with that of the practical grower.

IV. The Federal portion of the Entomological Division has been devoted to comprehensive studies of an apple pest (the ribbed cocoon-maker of the apple), two serious grape pests (the grape-berry moth and the rose-chafer), and three destructive shade-tree pests. Many new facts have been learned about these insects, and practical methods for controlling them have been tested. The Extension Work of this Division of the Station has been devoted largely to grape pests. An extensive series of experiments are embodied in Bulletin 215, The Grape Leaf-Hopper. Tests of remedial measures against the grape root-worm were continued and important results obtained. A new grape pest, the grape blossom-bud gnat, was discovered and studied. About thirty prominent fruit-growers coöperated with this Division in spraying experiments against the plum curculio, the quince curculio, the rose-chafer, the grape-berry moth, and the grape root-worm, and some valuable results were obtained. Much has also been accomplished in the preparation of collections of insects for schools which are doing satisfactory work in Nature-Study.

V. In the Department of Chemistry two principal lines of work have been carried on under the Federal Division, namely, a study of the chemical composition of some of the successful alfalfa soils of the State, and an investigation of the sugar content of sweet corn. The work under the State appropriation has been of a miscellaneous character, including analyses of numerous samples of insecticides, feeds, fertilizers, etc., in response to requests from various sections of the State.

VI. The Federal Experiment Station work in Botany has consisted chiefly of the investigation of mushrooms and the wood-destroying fungi, one bulletin having been published on the injuries to fruit, shade, and forest trees caused by the higher fungi. The assistants in plant pathology (on the State fund) have been largely occupied with the investigation of the diseases of plants caused by the molds, mildews, rusts, smuts, and black fungi.

There remain for report certain lines of activity which are maintained exclusively by the State appropriation for the promotion of agricultural knowledge. These embrace Extension Courses in Dairying, Nature-Study, and General Agriculture, for farmers, farmers' wives, school children, and school teachers throughout the State.

VII. The regular Short Dairy Course (State Extension work) was attended last winter by eighty-nine men and one woman, coming from thirty counties of the State and from three neighboring states. This class was much larger than any preceding one and taxed our facilities to the utmost. All students qualified to fill good positions have found them without trouble and there is a demand for more of these men than are available. The Professor of Dairy Industry and two of his assistants have traveled in all parts of the State visiting former students, criticising their work and, whenever opportunity afforded, the work of others engaged in the same line, thus doing much to improve the quality of the dairy products of the State. Important experiments have also been undertaken in connection with practical market-milk, butter, and cheese work, the line of investigation of greatest importance being one which has to do with the greater purity of these products.

VIII. The Bureau of Nature-Study, conducted as a part of the State Extension Teaching in Agriculture, has organized and conducted throughout the schools of the State 560 Junior Naturalist Clubs with a total enrollment of 15,385, and has distributed literature to 19,221 other children who have expressed an interest in gardening and rural life. Owing to the changing conditions in the schools from year to year considerable difficulty is experienced in keeping in touch with the children, and as a remedy the Supervisor urges that children's gardens be established in the schools of the State as a form of manual training, thus enabling the Bureau to centralize its work in such schools and to reach the children more effectively and continuously. In many instances, it is believed, the Bureau could so far assist in instruction as to make a special teacher unnecessary.

IX. In the Home Nature-Study Course, also, (State Extension work) lessons have been published during eight months of the year covering such objects as food stored in seeds, study of the maples, some birds of economic importance, the onion, the clovers, the distribution of the seeds of weeds, the introduction of alfalfa, etc. These leaflets are sent out regularly by request to 726 teachers in the State, exclusive of 23 training classes with an enrollment of 558 pupil teachers.

X. The short winter courses, conducted under the State appropriation by the Cornell University College of Agriculture, constitute an important feature of the University Extension Teaching in Agriculture. The attendance on these courses during the winter of 1904 was 136 (representing 39 counties of the State) as compared with 121 during the previous winter, and with the inauguration this winter of the short course in Poultry Husbandry in addition to the former courses in Dairying and General Agriculture, a still larger registration is expected. That these winter courses are meeting a real need of the farming population of the State is certain and it is proposed to extend them to cover courses in Agronomy, Animal Husbandry, and Horticulture as soon as the facilities available will permit.

The most important developments in the Farmers' Reading Course (State Extension work) have been the substitution of "Discussion Papers" for the "Quiz," thus increasing the amount of personal correspondence between the reader and Supervisor and making the former a collaborator instead of a mere interrogatee; the revision and illustrating of bulletins, rendering them more clear and intelligible; the increase in the number of Farmers' Reading Clubs; and the beginning of a correspondence course in advanced reading under the guidance of the Supervisor. Twenty bulletins, arranged in four series of five bulletins each, have now been published dealing with the Soil and Plant Growth, Stock Feeding, Orcharding, and Poultry Husbandry, and two more series, one on Dairying and one on the Farm Home, are soon to be added. It is then proposed to cease publishing new bulletins to avoid the danger of making the course unwieldy and hence less efficient. The enrollment in this course during the past year was 5,179, bulletins being sent only to those persons who acknowledged their receipt.

XI. The Farmers' Wives' Reading Course (State Extension work) had an enrollment of 6,555 when the reading year closed last spring. Five bulletins were issued during the year dealing with subjects of interest to the homekeeper.

In all the Extension courses discussion papers are sent out at stated intervals to all regularly enrolled readers and when such papers are returned each is carefully read and if questions are asked or an opportunity is given for a reply, a personal letter is sent to the reader.

Such in brief have been the varied and extended activities of the Cornell University Agricultural Experiment Station and the Division of Extension Teaching in Agriculture during the past year. With the limited facilities at hand, this work has taxed the College of Agriculture, which is the agent of the Federal Government and of the State, to the utmost. As soon, however, as the new buildings for the New York State College of Agriculture, which were authorized by the last Legislature at a cost of $250,000, are completed, the congestion in class-room, laboratory, and work-room will be largely done away with and Director Bailey and his able coadjutors will be able to do their important work unhampered by the disagreeable annoyances to which they have been subjected in the past.

I have the honor to be your obedient servant,

J. G. SCHURMAN,
President of Cornell University.

SPECIAL NOTICE.

[*The accompanying report embodies the publications of the Experiment Station only, as described in sections I–VI of the above letter. A report will later be published by New York State which will include this report and also the report of the work and publications of the Extension Bureau in Agriculture, as described in sections VII–XI above.*]

REPORT OF DIRECTOR.

November 25, 1904.

To the President of the University:

SIR:—I herewith submit my first annual report, as Director of the Agricultural Experiment Station of Cornell University and Director of the College of Agriculture, of the work of the Experiment Station for the year ending June 30, 1904, and of the operations so far as experimental work is concerned, under the State fund for extension of agricultural knowledge for the year ending September 30, 1904. The reports of the heads of the various Departments which are submitted herewith, sufficiently explain the character of the work that has been performed, and the growing activities of the College of Agriculture and its Experiment Station Department.

Very respectfully submitted,
L. H. BAILEY,
Director of the College of Agriculture
and the Agricultural Experiment Station.

DEPARTMENT OF AGRONOMY.

The following experiments are under way in the Department of Agronomy. Some of the experiments in the attached list are conducted primarily for the sake of the direct information it is hoped to gain, but most of them are being prosecuted on account of their bearing upon some of the larger problems of vital importance to New York agriculture. The two problems that stand out prominently are : (1) the improvement of meadows and pastures of the state ; (2) the substitution of some easily digested food of proper composition, to take the place of the western grains and of by-products now purchased so largely by the New York farmer. The importance of these problems may be indicated by the following comparison. New York raises 1¾ tons of hay per animal unit, Illinois ¾ tons. New York raises 800 pounds of concentrates (maize, oats, barley and rye), Illinois 4800 pounds per animal unit.

The working out of this second problem will require the coöperation of the departments of Animal Husbandry and Agricultural Chemistry. A few of the plats enumerated in the attached list, such as Nos. 11, 12 and 15 are maintained primarily for the instruction of the students.

The Extension Work of the Department of Agronomy of the College of Agriculture is in the immediate charge of John L. Stone, Assistant Professor of Agronomy, who has carried the work forward in an eminently satisfactory manner. I submit herewith his report of the work of the year ending October 1, 1904. During the year Professor Stone has prepared for publication that part of Bulletin No. 216 which treats of destroying wild mustard by means of the copper sulphate spray, and Bulletin No. 221 on Alfalfa in New York. John W. Gilmore, Instructor in Agronomy, and Samuel Fraser, Assistant Agronomist, have both devoted some time to the Extension work, by giving lectures to Winter-Course students and at farmers' meetings, and by answering letters concerning topics with which they are particularly familiar.

Experiment work for 1904.

1 Timothy.
  - a Selection and breeding work.
  - b Rate of seeding experiment.
  - c Influence of size of seed on yield.
  - d Fertilizer trial.

2 Pasture grass experiments. Area 11 acres, divided into 22 main plats.
  To determine the behavior of various grasses and clovers
  - a When sown alone.
  - b When sown in various mixtures.

To determine the effects of different fertilizers on these grasses.

To study the root system of these grasses.

3 Alfalfa.
  a Selection and breeding work.
  b Soil and inoculation trials.

4 Field Beans.
  a Influence of early and late preparation of soil on growth and yield.
  b Botanical work with varieties.
  c Selection and breeding work.
  d Trials with formalin treatment for anthracnose.

5 Buckwheat.
  Influence of early and late preparation of soil on growth and yield.

6 Oats.
  a Selection and breeding work.
  b Rate of seeding trials.
  c Cultivation trials.

7 Soy Beans.
  a Selection and breeding work.
  b Trial of two varieties for forage.
  c Trials with corn for silage.

8 Cow peas.
  a Selection and breeding work.
  b Trial of varieties for forage (coöperation with United States Department of Agriculture).

9 Potatoes.
  a Selection and breeding work.
  b Studies of quality.
  c Spraying work.
  d The influence of sprouting potatoes at various temperatures upon yield.

10 Root crops.
  Mangolds, Half Sugar Mangolds, Parsnips, Carrots, Rutabagas, Turnips, Hybrid Turnips, Kohl Rabi, Cabbages.
  Objects.
    Test of varieties.
      To ascertain the yield of roots through a period of years.
      To compare the yield of dry matter per acre with that of corn.
      To note variation and select types considered suitable for this locality.
      To ascertain whether the specific gravity of the root and juice may be used for determining
        Dry matter content.
        Keeping quality.
        Actual feeding value.
        And used as an aid in selection.

11 Wheat.
  Trial of varieties.

12 Corn.
  a Selection and breeding work.
  b Trial of certain selected varieties for yield and forage purposes.

13 Farm Economy.
  a Bean-wheat-meadow rotation—with and without fertilizers.
  b Cover crop experiments.
  c Potato-bean-wheat-meadow rotation, with and without fertilizers.

14 Ginseng.
  Culture experiments.

15 Grass garden.
  Demonstration plats of grasses and clovers.

16 Sugar beets.
  Culture experiments (in coöperation with United States Department of Agriculture).

17 Farm Mechanics.
  Trials of draft of implements.

THOMAS F. HUNT,
Professor of Agronomy.

EXTENSION EXPERIMENTS IN AGRONOMY.

REPORT OF ASSISTANT PROFESSOR J. L. STONE.

For the Extension year beginning Oct. 1, 1903, my first work was in connection with the work of the previous season. During past seasons, our lists of experimenters have included the names of many Long Island parties, but owing to the distance from Ithaca and the impossibility of reaching all, I had not visited Long Island. A trip to this locality was begun Oct. 3, 1904, and extended to Oct. 15, visiting Amityville, Lynbrook, Springfield, Jamaica, Westboro, St. James, Lake Grove, Mattituck, Greenport and Orient. This was the last extended trip of the season.

In planning for the coöperative experiments in agronomy for the season of 1904, the following list of experiments was prepared and sent as a part of Bulletin 216 to all addresses on the bulletin mailing list and as a separate circular to many others. The work in plant selection and breeding (Nos. 20, 21 and 22) is under the supervision of Mr. J. W. Gilmore, assistant in agronomy.

Outline of Coöperative Experiment in Agronomy or Field Crops for 1904.

I. Agronomy or Field Crops.

No. 1. *Alfalfa:* (a) The experimenter to report the conditions existing, the manner of treating the crop and the successes and the failures met in his experience. The direct experiments suggested are

(b) Seeding with and without a nurse crop;

(c) Treating a portion of the area with lime;

(d) When nodules are not found on the alfalfa roots, obtain some infected soil from a field where nodules are abundantly produced and scatter it over a portion of the area;

(e) Apply stable manure to a part of the inoculated area and also to an uninoculated plat.

No. 2. *Oats.* A test of three varieties of oats from selected seed. Seed of each variety sufficient for a plat one rod by two rods will be sent to the experimenter. Weight of total crop and of grain to be determined in each case.

No. 3. *Fertilizers.* A test with nitrogen, phosphoric acid and potash singly and in combinations, eight plats 1-20 to 1-10 acre each. The set comprises 260 lbs. of chemicals that cost the experimenter four dollars.

No. 4. *Potatoes.* (a) Test of varieties. Five pounds of each of three selected varieties will be furnished by the college. To be planted on a definite area and crop weighed.

(b) Cultural experiment. A comparison of the Cornell method with your own as described in Circular No. 18.

No. 5. *Sunflower* in corn for silage. Seed will be furnished for a test.

No. 6. *Soy beans.* A test of several varieties with a view to determine

(a) Their grain producing qualities,

(b) Their forage producing qualities,

(c) Their green manurial qualities.

(d) Adaptation to growing with corn to improve the quality of silage.

(e) Is artificial inoculation necessary?

(Experiments at the Cornell station indicate that this desirable natural stock food may be grown to advantage in New York.)

No. 7. *Field beans.* A test of several leading sorts. About one pint of seed of each variety furnished by the College.

No. 8. *Buckwheat.* (a) Variety test. Seed of each variety sufficient for a plat one rod by two rods will be sent to the experimenter. Weight of total crop and of grain to be determined in each case.

(b) Cultural experiment. Plow one plat early and harrow frequently till seeding time. Plow another plat just before seeding.

No. 9. *Winter vetch and rye.* A test of the combination as a cover crop, which may be used as a soil renovator, as early spring pasture, as a forage crop or for the production of seed.

No. 10. The destruction of certain weeds such as wild mustard, alfalfa dodder, devils paint brush, wild carrot, rag weed, smartweed, etc., by spraying with chemical solutions.

No. 11. *Testing the effect of lime on soils.*

No. 12. *The inoculation of legumes by means of artificial cultures.*

No. 13. *The renovation of pastures and meadows without plowing.*

II. Plant Selection and Breeding.

No. 20. *Potatoes.* An experiment in selection for the purpose of increasing the yield.

No. 21. *Potatoes.* An experiment to determine the effect of different soils in different localities upon the yield and quality.

No. 22. *Oats.* An experiment in selection for the purpose of increasing the yield.

The objects sought after in suggesting to the farmers that they take up the work indicated by the above list of experiments are several:

First, I would name gaining information in regard to the crop or method employed in the experiment.

Second, to encourage the farmers to undertake to solve for themselves some of the problems that cannot be so well solved for them on the Station grounds as upon their own farms.

Third, the coöperative experiment is a means of bringing the College of Agriculture into closer touch with the farmers. Of course the farmers choose such experiments as they are most interested in or which circumstances at the time make it most convenient for them to carry out.

The number of farmers undertaking the various experiments during the present season is as follows:

Alfalfa (including those started in 1902 and 1903, most of which are still running	164
Oats	34
Fertilizers	8
Potatoes (Variety test)	68
Sunflowers in corn	9
Soy beans	37
Field beans	25
Buckwheat	14
Vetch and rye	10
Weed destruction by chemicals	12
Liming soils	1
Inoculation of legumes	39
Renovation of pastures and meadows	5

This makes some 426 experiments, implying the use of more than one thousand individual plats. These experiments are located in forty-one counties.

In addition to these general experiments which were arranged by means of the circulation of printed matter and the voluntary action of the farmers, a number of others of a somewhat more exacting character were arranged through personal visitation in localities where special problems exist.

At four points on Long Island, two in Saratoga Co. and one in Oneida, Co., a study is being made of the best methods of renovating depleted sandy soils. Various crops that are reputed to have special value as renovators of sandy soils, such as cow peas, soy beans, spurry, rye and vetch, buckwheat, etc., are being tested with a view of ascertaining their value in these localities.

In some cases, dressings of fertilizer are added to assist the crop in making a start. These experiments need to be continued several seasons in order to arrive at any satisfactory conclusions. Some of them have been running two and three years.

Another experiment has for its object to determine the effect upon the soil of a rotation from which leguminous plants are excluded in comparison with a rotation in which several legumes are included. One of these is now in its third season. It should be continued at least as far as the seventh season when the second wheat crop will be taken and may be used as a measure of the effect of the two rotations upon the productivity of the soil. A composite sample of the soil was taken at the beginning of the experiment for examination in the laboratory in such a way that at the end a similar sample may be taken from the same points for comparison. It is believed that these experiments, if carried through, may have an important bearing on systems of soil management.

Two of the more important problems before New York farmers are: (1) how to handle their lands so as to secure remunerative returns without depleting them; and (2) how to handle the already depleted soils so as to bring them again into productivity.

Last fall it was discovered that dodder was attacking some of the alfalfa fields of the state. This pest frequently becomes very destructive and as the older methods of combating it led to the destruction, or at least severe damage, of the alfalfa in the attacked field, it was thought wise to attempt its destruction by the use of chemicals. As this method had proven effective in destroying wild mustard without serious injury to certain crops in which it grows, it was hoped to find satisfactory methods of destroying the dodder without injury to the alfalfa. Several acres of badly infested alfalfa were secured in Onondaga Co. to experiment upon. At this writing the results have been, at best, only partially successful.

During the year, I have prepared for publication that part of Bulletin 216, which treats of destroying wild mustard by means of copper sulphate spray, and Bulletin 221, alfalfa in New York. Numerous short articles have been contributed to the agricultural press in answer to questions submitted to this office by the publishers.

Considerable time has been devoted to the correspondence that comes to my desk. Sometimes this has been so abundant as to require fully one-third of my time to keep the work up.

DEPARTMENT OF HORTICULTURE.

I beg to offer the following brief report of the work completed and in progress in this Department during the past year :

1 *Field work in the State.*

- (a) A geologic and orchard survey of Wayne County. Report written, but not published. The data collected affords important evidence upon the subject of orchard management. The same type of investigation is now under way in Orleans County.
- (b) A somewhat extended examination of the condition and causes of the wide-spread injury of fruit trees was made last spring and will be continued through the season. (A joint investigation by State and Federal funds.)

2 *Studies on the Station grounds.*

- (a) Shading experiments : These have been conducted for two years and were continued under glass during the winter. The objects of the experiments are twofold : (1) To find the commercial bearings of the practice ; (2) to ascertain what structural and physiological changes occur in the plant under shaded conditions.
- (b) Forcing experiments with tomatoes and beans. This included tests of varieties and trials of methods. Important results in the use of hydrocyanic acid gas for the suppression of white fly have been obtained. The adaptability of pole Lima beans for forcing purposes has been tested.
- (c) Spraying experiments with insecticides and fungicides have been again conducted to the extent of checking and comparing more comprehensive trials made in the State.
- (d) Studies of new varieties of fruits, notably plums and pears.

3 *Publication.*

The horticulturist has assisted in giving to the public in Bulletin 215 the results of extensive experiments conducted in Chautauqua County for the suppression of the grape leaf hopper. The Spray Calendar, Bulletin 217, has been revised and republished. The results of experiments with dust spray appear in Bulletin 216.

4 *Correspondence.*

The correspondence of the Department is increasing steadily, and a considerable amount of time is occupied each day in answering questions asked by writers living in country and town. I regard this as a very important part of the duties of the horticulturist.

Extension Work.

The Extension work of this Department under the State act for the promotion of agricultural knowledge, divides itself into two parts : (1) instructional ; (2) investigational.

(1) Instructional.

(a) The horticulturist has attended the meetings of a considerable number of farmers' clubs, granges and fruit-growers' associations of the state during the year. He has endeavored to present appropriate addresses on these occasions and give such information as training, observation and experience dictated. Such meetings are each year tending to form a closer bond between experiment station worker and fruit grower.

(b) *Orchard inspection.* The Department has been appealed to several times the past season by orchardists who were either suffering a general type of injury, or by individuals who were unable to diagnose some special trouble affecting their orchards. Whenever practicable, personal visits have been made, the situation carefully studied and suggestive reports offered. One of the best examples of this kind of work is afforded by the grape situation in the Keuka Lake district last spring. In the latter part of June, grape growers became puzzled by the peculiar behavior of some of their grape vines. These had leaved in a normal manner, but now were either refusing to grow, or were actually withering. On request of representative fruit-growers, the horticulturist spent two days in the region investigating the trouble under varying conditions. Two meetings were also held at Hammondsport where the trouble was discussed with the grape growers. It was found that the severe cold of the winter of 1903–4 had caused the death of the roots of many vines in exposed situations, or in harsh or badly prepared soil. A press bulletin was issued at once embodying suggestions for the treatment of weakened vineyards. The general subject of winter-injury of fruit trees was investigated in different parts of the state and suggestions offered by letter and through the press.

(c) *Correspondence.* The volume of queries directed by mail to the Department of Horticulture is increasing annually. Over four thousand letters relating to official subjects were written and dispatched last year. The fact that fruit-growers frequently use the long distance telephone to secure advice from the Department of Horticulture suggests a most satisfactory attitude of confidence on the part of the orchardist. Serious injury of crops may sometimes be averted by prompt action.

(d) *Civic improvement.* The horticulturist has given considerable attention to the movement now so general over the land for the æsthetic and sanitary improvement of conditions in village and town. The influence of village and city-living upon country homes is important. A striking improvement in the æsthetic turn of the country home has taken place during the past five years. Each year sees a larger number of lawn mowers purchased and used—a larger number of lawns kept in order. Village improvement societies, like all altruistic organizations, are supported by those who are generous in the use of their time. These societies are not easily kept alive. They need and deserve encouragement. The officers of the Department of Horticulture have aided these societies by delivering illustrated lectures and by offering specific advice after examination and consultation regarding the planning and planting of parks and other public grounds.

(2) Investigational and illustrative work.

Owing to lack of means, the work in this field was necessarily curtailed the past year. The following paragraphs embody the main features of this type of field work :

(a) *Dust versus liquid sprays.* A preliminary report on this subject was offered last spring (1904) covering work done the previous season. The experiments have been continued this season and the results will be published as soon as possible. The efficiency of the dust spray in preventing brown rot of the stone fruits, has been especially investigated this year.

(b) *Cover-crops for orchards.* These have been investigated for the past four seasons. The intelligent use of suitable green covers for the orchard soil in the latter part of the season is an essential feature of successful fruit-growing in most parts of New York. When to sow the crop ; what to use ; its effect upon fruit and tree in the average of seasons—are questions which can only be answered approximately till lengthy experiments have been concluded.

(c) *Coöperative work with members of Agricultural Experimenters' League.* The following have been offered to the members of the State Experimenters' League as offering suitable fields for coöperative effort. Each experiment has been undertaken by members of the League, some of them being many times duplicated :

No. 30. *Orchard cover-crops.* 3 plats. A comparison of the value of hairy vetch, cow peas, and mammoth clover, in apple, plum, pear or peach orchard. All plats in cover-crop experiments ⅛ acre in extent. Keep soil thoroughly stirred from spring until middle of July, when seed should be sown. Seed furnished by the College.

No. 31. *Orchard cover-crops.* 3 plats. A comparison of cover-crop values of alfalfa and mammoth clover sown separate and mixed.

No. 32. *Spraying experiment.* Compare lime and sulfur with Bordeaux mixture as a fungicide. Prepare according to directions given in Spray Calendar.

No. 33. *Dust spray vs. Bordeaux mixture.* (A limited number of experiments.)

No. 34. *Spraying to prevent peach and plum rot.* Ammoniacal copper carbonate. Spray twice as fruit is ripening. Spraying material furnished by the College.

No. 35. *Thinning fruit.* Conduct careful tests on early apples, peaches and plums.

No. 36. *Strawberry.* Variety test.

No. 37. *Raspberry.* Variety test.

(d) *Volunteer orchards.* The planting of volunteer orchards was first recommended by L. H. Bailey, then Professor of Horticulture at Cornell University. This was to be a coöperative movement between nurserymen and orchardist, the former furnishing trees of high-grade varieties, the latter planting and caring for them; the whole enterprise to be directed by the horticulturist of the Experiment Station and a committee of the Western New York Horticultural Society. The establishing of these orchards has progressed steadily. There are eight now planted with a number of applications in hand.

Finally, there is a keen demand for information, for investigational and illustrative experiments by the fruit-growers of the State. The entire time of one man should be given to this work. The fruit, vegetable and floricultural interests of the State are large and deserve such attention. It is urged by the horticultural public. The request is reasonable and should be granted.

JOHN CRAIG,
Professor of Horticulture.

DEPARTMENT OF ANIMAL HUSBANDRY.

The experimental work in the Department of Animal Husbandry has progressed satisfactorily during the past year. During the year two bulletins have been published, No. 213, Methods of Milking and No. 220, The Utilization of Skimmed Milk in Feeding Pigs. The experiment that has now been carried on for four years on the possibility of increasing the percentage of fat in the milk of poorly fed cows has been concluded and the results are ready for publication. It is expected to publish them in the near future.

During the year experiments have been inaugurated looking toward the economical production of beef in New York State and a study of the possibility of the development of the early lamb industry is being made. These, with some further work that is laid out in feeding swine, constitutes the main investigations in progress in this Division.

Extension Work.

During the year much work has been done throughout the state in supervising the records of production of cows. This has been done at the request of the owners who have borne the expense of the supervisors in the field. Clerical work in the office and the maintenance of necessary equipment have fallen upon the University and have been done by the regular office force. The greater part of this work has been done for breeders of Holstein Friesian cattle who have a system of advanced registry based upon records officially authenticated by the Experiment Station. In all, during the past year, there were supervised for this Association the records of 483 cows for seven days each and 44 cows for 30 days each. These cows were owned by fifty-three different owners in the state.

There were also supervised eight weekly records of Brown Swiss cows and one weekly record of a Jersey cow. In addition regular monthly inspections of the production of nine Guernsey herds including about thirty cows have been made. This work has brought the Station in close touch with about 75 breeders of thoroughbred cattle in the state, and while somewhat laborious, has been the means of extending the influence of the Station in a very satisfactory way.

A large part of the extension work in Animal Husbandry is along the line of Poultry keeping and a great additional impetus to the work in Poultry Husbandry has been given by the appointment of an Assistant Professor in this Department, and while the present year has been largely given to organization, still material progress has been made. For the details of this I refer to the report of Assistant Professor Rice which is appended hereto.

H. H. WING,
Professor of Animal Husbandry.

EXPERIMENTS IN POULTRY HUSBANDRY.

REPORT BY ASSISTANT PROFESSOR RICE.

EXPERIMENT I.

Effect of Various Condition of Housing and Types of Houses on :

a Egg production and cost.
b Fertility of eggs.
c Vitality of chicks.
d Amount of food consumed.
e Gain in weight and cost.

RECORDS KEPT.

a Highest and lowest temperature during night and day.
b Amount of moisture in the air.
c Amount of carbon dioxide in the air.
d Amount of ammonia in the air.
e Density of sunlight daily.

EXPERIMENT II.

Individual Records by Trap Nests, to learn :

a Difference in prolificacy of different strains of the same breed.
b Influence of age upon egg production.
c If there are any characteristics distinguishing the best from the poorest layers.
d Comparative prolificacy of large and small individuals of the same breed.
e Comparative prolificacy of layers of large eggs, with layers of small eggs of same breed.
f Comparative prolificacy of the more broody and less broody individuals.
g Whether there is any difference in the fertility of eggs or vitality of chicks between individuals that have laid the most eggs and least eggs during early fall and winter.
h Whether there is any difference in fertility of eggs and vitality of chickens between hens and pullets.
i To establish a "Cornell College of Agriculture Strain" of heavy layers with all the breeds under experiment by breeding only from hens which have given abnormally high egg yields and show great vitality.

In addition to the above, coöperative experiments are being conducted at Henry Van Dresser's, Cobleskill, New York. Sixty Single Comb White Leghorn hens from three different strains are being fed to determine differences in prolificacy, cost of producing eggs, fertility of eggs and vitality of chickens, etc.

Data is also being secured in connection with these experiments to determine the cost of rearing chickens and variation in temperature of incubators as indicated by the position of the thermometer.

III.

Development of the Poultry Department; During the year many changes and additions have been made to the poultry plant and equipment. The University has erected a new building, which is now approaching completion, that is to be the general headquarters of the Poultry Department. This building is 46 feet long and 30 feet wide. It contains two stories and a sub-basement. The latter contains an incubator cellar 30 feet square, slaughter house and packing room 16 x 20 feet, and root cellar 10 x 16 feet. The first floor contains a large feed room, museum, carpenter shop and locker room. The second floor is to be finished off in living rooms to be occupied by the student poultry assistants.

During the year nearly all of the poultry yards have been enlarged and the old fences replaced with new. Many of the houses have been made warmer for the temperature experiments, partitions removed to keep larger flocks, all doors swung on double hinges to save time, and broody coops added. Trap nests have been built and placed in nearly all pens. The stock has been materially increased and it now consists of eleven varieties of fowls and three varieties of ducks, aggregating a total of about 425 mature and 900 young stock, of which some 300 or 400 are late hatched chickens.

On July 1st, the inventory valuation of the Poultry Department was as follows:

Stock	$861	25
Tools and Implements	195	70
Incubators and Brooders	359	50
Materials and Supplies	84	80
Office Equipment and Supplies	100	97
	$1602	22

The Buildings to-day (Sept. 30, 1904), would be valued at about $1750.00, making a total valuation of $3352.00.

DEPARTMENT OF DAIRY INDUSTRY.

Extension experimental work has been limited, since most of the energies of this department are given to teaching. However, some interesting and promising experiments have been undertaken. They must be continued for a longer period of time and be conducted upon a larger scale before results are published. One experiment is upon the churning of cream within a few hours after separation, a large proportion of starter being used instead of a long period for ripening. This method of making butter would seem to have some marked advantages over the present system. It is proposed to learn just how great these advantages are and to determine whether they would be offset by disadvantages. In the creamery division also some experimental work upon the salting of butter and the "overrun" has been planned.

Some experiments upon making cheddar cheese in rectangular 10-lb. blocks have been completed, but it is desired to repeat them upon a larger scale. The purpose is to determine if this shape of cheese is preferable to the round form for retail trade. Every practicable means for improving the attractiveness as well as the quality of cheese should be encouraged as this means much for the enormous cheese interests of New York. Nearly half of the cheese made in the United States is the product of New York factories, so almost any fair effort in this State to increase the demand for cheese would be justified. Cheese is an exceedingly nutritious food and at present prices it is much cheaper than most other foods, especially meats. The public needs to be educated upon this point so it will more largely substitute cheese for meat in the dietary.

In the market milk division, experiments are in progress upon the standardization of milk and cream and the market requirements along this line are being studied. A good beginning has been made also upon a study of the greatest of all problems now before our dairymen, namely, the economical production of sanitary milk. With the advance of sanitary knowledge which seems to have almost universal application, dairying is receiving its share of the steadily growing pressure for better methods and a more cleanly product. Probably dairymen are responding as satisfactorily as many who are engaged in other lines. But they are hampered by want of knowledge of the subject. In the last few years there have been established in this and other states a few dairies that are making milk that is well-nigh perfect. At these dairies there is observed almost every measure that has been suggested whereby the contamination of milk may be avoided. Some of these measures are costly and the result of their adoption is a high-priced milk. There is some demand for this high-priced and high-class milk although it retails usually for from

12c. to 18c. per quart. What is now needed is a thorough study of the various sources of milk contamination each by itself and the description for our dairymen of the most efficient and economical means for reducing contamination. It is hoped that necessary funds can be provided so that much progress can be made along this line in the near future.

R. A. PEARSON,
Professor of Dairy Industry.

DEPARTMENT OF CHEMISTRY.

Two principal lines of work have been carried on under the federal division : a study of the chemical composition of some of the successful alfalfa soils of the State, and an investigation of the sugar content of sweet corn.

Many failures to grow alfalfa are reported, and frequent questions are asked as to the kind of soil and fertilizer best adapted to this crop. During the past year, complete chemical analyses have been made of 54 soils on nearly all of which alfalfa is successfully produced. In general, the results show that the soils are abundantly supplied with the elements of plant food—especially nitrogen and potash. It is desirable to learn what proportion of the nitrogen was contained in the soil and how much the alfalfa "fixes." This will have an economic bearing on the fertilizing of alfalfa fields.

Analyses of samples from 26 ears of Stowell's Evergreen sweet corn for sugar content, showed a variation from 2.19 per cent to 5.66 per cent—on a moisture content of about 10 per cent. The balance of the kernels on the ears was planted in the spring of 1903. Samples from the ears harvested are now in process of analysis. If, from the results that the sugar content can be improved, the work of chemical selection will be continued.

Extension Work.

The Extension work under the State appropriation has been of a necessity of a miscellaneous character. In response to requests from different parts of the State, analyses have been made of 15 samples of insecticides, 16 feeds and fertilizer analyses of 13 miscellaneous samples.

Ten samples of eggs were examined for protein and fat content for the Poultry Division.

In connection with the Department of Agronomy in coöperative experiments on potatoes, 39 samples were analyzed for starch content, also 56 samples of soil were examined for moisture content.

Respectfully submitted,
George W. Cavanaugh,
Assistant Professor of Chemistry in its relations with Agriculture.

REPORT OF THE ENTOMOLOGIST.

I herewith transmit a report on the entomological work of the Station during the past year. The report has been prepared by the Assistant Entomologist at my request, as nearly all the entomological work has been done by him.

Very respectfully yours,
J. H. COMSTOCK,
Professor of Entomology.

EXPERIMENTAL WORK IN ENTOMOLOGY.

REPORT OF ASSISTANT PROFESSOR SLINGERLAND.

As in previous years, the work of the Entomological Division of the Station has been concentrated along a few important lines. Some work has been continued from past years, and considerable new work has been accomplished or is now in progress.

I continued the study of the insect pests of the grape in the Chautauqua region. Spraying experiments with a strong poison to kill the beetles of the grape-root worm were made under my direction and some very striking and encouraging results were obtained. I am now conducting an extensive cultivation and spraying experiment against the insect by which I hope to demonstrate that this serious menace to grape culture can be controlled.

The grape berry-moth has been unusually destructive in some Chautauqua vineyards recently. Working under my direction some of the vineyardists successfully controlled this insect by early sprayings with arsenate of lead, and by hand-picking and destroying the half-grown infested fruits. I am now studying its life-history and have already demonstrated that it is not the European species, as entomologists have always supposed ; our American species has quite a different appearance and life-history.

The grape leaf-hopper has now entered its "down" or non-destructive period in the regions so seriously infested in 1901 and 1902. The details of an extensive campaign against this insect were published in January as bulletin :

No. 215. "The Grape Leaf-Hopper."

Another insect pest of the grape, the rose chafer, which also attacks roses, strawberries and orchard trees, was unusually numerous and destructive during the past year over limited, sandy areas in several localities in widely separated portions of the state. I am now investigating the life and breeding habits of this insect, and several fruit-growers are coöperating in experiments, which I expect will result in practicable methods for controlling the rose chafer in New York.

In connection with a student, Miss P. B. Fletcher, a careful study was made of the Apple Bucculatrix, which we renamed "The Ribbed Cocoon-Maker of the Apple." The results of this work appeared in December as bulletin :

No. 214. "The Ribbed Cocoon-Maker of the Apple."

Plant-lice were unusually abundant in orchards and nurseries last summer and I investigated several destructive outbreaks. In July, a Press Bulletin was issued on, "Destructive Work of Plant-lice in New York Orchards." I made a detailed study of some of the apple aphids a few years ago and expect to get our extensive notes ready for publication during the coming year.

The pear psylla ravaged pear orchards all over the State last summer and unprecedented damage resulted. A Press Bulletin was issued in July on "The Pear Psylla again Destructive in New York Pear Orchards." A few pear growers were also induced to make some coöperative experiments with lime-sulphur and whale-oil soap sprays applied in March to destroy the adult psyllas then in hibernation.

I have just completed an investigation of two serious shade-tree pests. Both are saw-fly leaf-miners, one working on European elms and the other on European alder. These insects have seriously marred several of these trees on the University Campus, and in other parts of the State for a few years past.

Work is progressing on the preparation of collections of insects to be sent out to the public schools coöperating with the College of Agriculture in Nature-Study work. In August I issued a Press Bulletin, entitled, "Insects Wanted." Some good material has been sent in response to this, and I have been rearing certain insects in order to illustrate the complete life-history of some of the common forms in these school collections.

Several coöperative spraying experiments are now in progress with fruit-growers in different parts of the State. A few pear growers applied winter sprays for the pear psylla. I furnished arsenate of lead to a dozen plum, cherry and peach growers, who are using it against the plum curculio. Several will use the same poison on grapes, strawberries and orchard trees when the rose chafer beetles appear about June 25th. I have also arranged with several vineyardists to use this poison for the grape root-worm beetles and the grape berry-moth caterpillars.

The correspondence of this Division continues to increase each year, and now requires a considerable portion of my time, but it is one of the most important and valuable features of my work.

Extension Work.

The entomological deparment of this Station has published during the past year under the Extension work the following bulletin :

No. 215. "The Grape Leaf Hopper."

Last year the pear psylla was very destructive throughout the State and many orchardists feared a similar outbreak this season. To determine if the adult psyllas could be destroyed during the winter with a lime-sulphur or whale-oil soap spray, I endeavored to interest about twenty-five pear growers in some coöperative experiments with these sprays during the winter. Unfortunately the weather conditions were such at the time the spraying should have been done that very few made the applications ; and as most of the psyllas in many localities were apparently killed by the severe winter, no definite results have been obtained from these coöperative experiments.

This department purchased 600 pounds of arsenate of lead and distributed half of it among 21 fruit-growers in lots of from 10 to 30 pounds each. The remaining 300 pounds of this poison was used in an extensive experiment against the grape root-worm in Chautauqua County. The total cost of this poison and its distribution was about $70. Twenty fruit-growers coöperated with this department in experiments with this poison against the plum curculio, the quince curculio, the bud moth and the rose-chafer. I have received reports from most of those who coöperated, and have also visited several of the orchards in which the experiments were made.

Unfortunately for my experiments, the plum curculio did not appear in very destructive numbers in most localities, so that few definite results were obtained with this poison spray. A few fruit-growers, however, obtained quite striking results, and are convinced that this pest can be controlled with a poison spray.

One quince grower reports good results from the use of this poison against the quince curculio.

In one test with this poison against the bud-moth, there was no evidence of its superiority over Paris green.

Five persons tested the arsenate of lead for the rose-chafer in widely separated localities in the State. This pest was not so numerous this year as usual, and the tests were, therefore, not so conclusive as we wished. However, from field and laboratory experiments, I am convinced that the work of this pest can be largely prevented and many of the beetles killed by thorough work with a strong mixture of this poison. I have studied the life-history of the rose-chafer somewhat in detail and have obtained some striking illustrations of its different stages. Our results should be further corroborated with more definite experiments next season.

Work has also been continued in the Chautauqua county grape region by this Department and largely directed against the grape root-worm. While pursuing this work my assistant, Mr. Fred Johnson, discovered a new pest of the grape, which in some vineyards was doing considerable injury. It may be called the "grape blossom-gnat." The adult insect has not yet been seen, but it is one of the *Cecidomyiids* and is thus closely allied to the Hessian-fly. The maggots of this little gnat live inside the blossom buds of the grape clusters, sometimes as many as 18 maggots being found in one blossom bud. They cause the bud to enlarge considerably, and before the blossom opens the maggots leave the bud and go into the ground. The unopened buds soon drop off, thus making ragged clusters.

Last year my experiments indicated that an arsenate of lead spray was effective against the grape root-worm, but as the experiments were on a small scale, and as some questioned the conclusions drawn therefrom, I determined to further test this method of fighting the grape root-worm on a large scale this season. About eight acres of a badly infested vineyard was sprayed twice with the arsenate of lead at the time the beetles were feeding on the foliage, and about an acre was left unsprayed for a check. A careful examination of 15 vines in the unsprayed portion of this vineyard revealed 151 clusters of eggs laid by the beetles. On 15 sprayed vines on one side of the unsprayed area only 11 egg clusters were found, and on 15 sprayed vines in another portion of the vineyard only 7 egg clusters were found. The foliage on the sprayed portions of the vineyard showed much less of the characteristic feeding done by the beetles. Similar examinations in another vineyard sprayed by the owner gave very encouraging but not so striking results, due largely to the spraying having been less thoroughly done. Several vineyardists purchased the large jarring machines, which some have advocated for controlling this pest, but in every case after a few attempts to operate the machines they were thrown aside and the spray pump substituted. I am fully convinced that a thorough application of this poison spray at the proper time will effectively control this serious pest, especially if it is used in connection with the cultivation method for destroying the pupæ.

I studied several different kinds of vineyard spray pumps in operation in the grape region, and tests were also made of two different pumps. This has resulted in my being able to give to the vineyardists some valuable suggestions along this line.

Work is progressing with the school collections of insects, but lack of funds and help have limited my operations along this line. I am prepared, however, to put up series of the life-histories of the potato beetle, the blow-fly, a mosquito, and the *Cecropia* moth. I also have quite a collection of miscellaneous insects. The working up of these school collections must necessarily be a slow process unless some one is detailed to pay particular attention to it and spend considerable time upon it. My manifold duties of teaching, investigating, lecturing and correspondence prevent my devoting much time to it.

I have in preparation a Bulletin giving the details of extensive spraying experiments against the grape root-worm in Chautauqua County, and will also include in it my study of the new "grape blossom-gnat." There may be sufficient material for another Bulletin to be published as Extension work upon the rose-chafer, and upon the coöperative experiments against this pest and the plum curculio.

The coöperative experiments have made considerable extra correspondence, and there has been the usual amount of inquiries regarding insects from constituents all over the State.

I am planning to continue the coöperative work with the arsenate of lead poison next season against the plum curculio and the rose-chafer, which I hope will appear in sufficient numbers to enable me to obtain more conclusive evidence of the value of this poison spray against such insects.

DEPARTMENT OF BOTANY.

Since the assistants in plant pathology (on the State fund) have largely been occupied with the investigation of the diseases of plants caused by the molds, mildews, rusts, smuts, and the black fungi, I have for several years given my attention chiefly to the investigation of mushrooms and wood-destroying fungi. There are four lines of work planned for:

1st, the investigation of injuries to fruit, shade, and forest trees caused by the higher fungi, whether true parasites or wound parasites. One bulletin (No. 193) has already been published on this subject.

2d, the study of the edible and poisonous mushrooms of the field and forest, for the purpose of preparing careful illustrations and descriptions which will aid the novice in the determination of species and thus extend the use of these plants as food, and also better to protect persons from the use of the harmful ones. Two bulletins (138 and 168) have already been published, and were in greatd emand. A large number of illustrations and studies has been made of other mushrooms, which I trust may be published from time to time. It is desirable now I think to publish these in the form of a monographic treatment of the most important species in certain genera, ex., the genus Agaricus, Amanita, Lepiota, etc.

3d, the investigation of the relation of the higher fungi to the decay of leaves and wood, to determine what species are concerned in the different stages of disintegration of wood, until it is finally reduced to the condition of forest "mold" and can again be made available for food to the higher plants. A great many observations have been made, but the work requires a long period.

4th, I have planned some experiments to determine whether the substance of mushrooms and wood fungi is available for food to the higher plants when the mushrooms decay, or when dried and pulverized.

The greatest need of the Botanical Division is a culture house which can be devoted exclusively to the investigation of parasitic fungi, and also for experimentation in the growth and life history of mushrooms and wood-destroying fungi. It should be built especially for this purpose with sections set apart for the growth of the hosts, inoculation rooms, incubation rooms, cellar with special compartments, an office and small laboratory, with a small adjoining garden.

Extension Work.

Two bulletins, the result of investigation have been, published.

Bulletin No. 218, Onion Blight, by H. H. Whetzel. For two years past has been quite serious in the onion growing section of central and western this disease New York. Mr. Whetzel gave a great deal of his time to the investigation of the disease, its prevalence and distribution, and the conditions which favor its growth in certain localities or fields, and also the means by which it is spread from one field to another. The results of his study have shown that with care and attention to correcting these conditions the spread of the disease may be largely checked and its introduction into new fields largely prevented. The difficulty of making sprays adhere to the slick surface of the onion leaves in the experiments the present year do not seem to have demonstrated that it can be prevented by the use of spraying mixtures. It is desirable rather that new fields should be selected for the culture of onions when old fields become infested by the spores and great care should then be used to prevent the introduction of the spores into the new fields from various implements used in cultivation, or by traffic from the infected field to the new one.

Bulletin No. 219, Diseases of Ginseng, was prepared by Mr. J. M. Van-Hook, who was one of the assistant's last year. This bulletin is of especial interest because it deals with the diseases of a plant rather recently having come under cultivation to considerable extent, and because very few diseases of this plant have heretofore been known. The study of one summer has brought to light a surprisingly large number of troubles due to parasitic fungi or physiological causes to which this plant is subject under the conditions of intensive cultivation practiced in ginseng gardens. Some of these troubles Mr. Van Hook succeeded in working out with considerable satisfaction, and has shown how by proper treatment they may be largely prevented In other cases very little knowledge was obtained concerning the cause of the disease and these form some of the subjects for future investigation by the division.

A large amount of correspondence has been carried on by the division in reply to numerous questions concerning fungous diseases of plants and concerning mushrooms. And also a greal deal of time has been spent in the identification of the diseases of plants sent in by farmers and gardeners of the State.

During September my attention was called to a serious annoyance caused by the luxuriant growth of certain plants in the town pond at Southhampton, Long Island. The annoyance consisted in the interference with navigation, because of the luxuriant growth of a water weed, and another phase of the annoyance was due to a foul odor emanating from decaying vegetation. The subject seemed of such importance that I made a trip to Southampton to investigate the trouble. I found that navigation was interferred with by the luxuriant growth of the slender water weed (Naias flexilis). This plant grows in shallow water and readily breaks free when disturbed and thus often floats in large masses in different parts of the pond. The foul odor I found was not due to a decay of this water weed as was supposed by the inhabitants, but was due to the decay of large quantities of one of the blue-green algæ, a microscopic plant which often grows in great abundance in ponds, ditches, small lakes, and also in reservoirs for the public supply of water. This organism is very easily killed by the hot sun and as it decays it emits an odor popularly known as the " pig pen " odor, which is very disagreeable. By study of the conditions of the pond I was able to make a report to the President of the City Improvement Society of Southampton, which should enable them to correct these conditions.

Work in Progress.

During the past year a large number of diseases of plants have been called to my attention and a number of different lines of investigations are already under way for the purpose of determining the cause of these troubles and means for their prevention. Investigation of these diseases is largely in the hands of assistant H. H. Whetzel, who is showing remarkable energy and success in the work upon the fungous diseases of cultivated plants in the State. The most important of these troubles which are now under investigation are as follows :

First, an alfalfa disease manifested in the form of brown spots on the leaves. This seems to have been quite serious and widespread throughout the State and is an important subject for investigation because of the large area of alfalfa cultivated. It appears that Mr. Whetzel has discovered the fungus associated with this disease and we hope by the careful study of its life history to be able to suggest proper methods of treatment.

Second, the rots of cherries, peaches and apples caused by a species of Monilia are being made the subject of special investigations since several species have been found, some of which attack leaves and twigs. It is important to study carefully the life history of these and to determine the distribution of the different species occurring on different trees, both cultivated and wild.

Third, the soft rot of ginseng roots, which was reported in Bulletin No. 219, has during the past year become a much more serious trouble than was shown to be the case during the first year of investigation. Mr. Whetzel has succeeded in isolating two organisms from diseased roots,—one a fungus, the other a bacterium, and investigations are under way to determine which one of these is responsible for the trouble, or to determine whether it is possible that the disease may be caused by the mutual relationships of the two organisms.

Fourth, the leaf spot disease of ginseng caused by a species of Macrosporium has been very injurious to many ginseng gardens this year. In some cases one-fourth to three-fourths of the plants in certain gardens having been killed. This subject has also taken considerable time, and investigations are under way to determine whether a fungus initiates the trouble and can be checked by the spraying of the plants or by disinfection of the gardens to kill the spores in the soil, etc., or whether it is a physiological trouble, which can be corrected by better attention to the conditions of culture.

Fifth, the association of a fungus upon injured apple limbs supposed to have been caused by winter freezing has led to an investigation of its relation to healthy trees. This single fungus seems to be present in a large number of cases, perhaps, quickly following the effects of freezing. In other cases it looks as if it might even initiate some trouble, or having gained entrance through small frozen areas might extend rapidly over larger portions of the tree causing great injury. While there seems to be considerable doubt of the fungus having much to do with the trouble it seems necessary to thoroughly investigate this in order to know accurately just what this relation to the injured apple tree is.

GEO. F. ATKINSON,
Professor of Botany.

STATEMENT OF RECEIPTS AND EXPENDITURES OF CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION FOR THE FISCAL YEAR ENDING JUNE 30, 1904.

RECEIPTS from the Treasurer of the United States as per appropriation for fiscal year ending June 30, 1904, as per Act of Congress, approved March 2, 1887		$13,500.00

Expenditures.

Salaries.		
Director and Administrative officers	$2,631.58	
Scientific staff	7,591.42	
Special	162.50	
		$10,385.50
Labor.		
Monthly employees	504.50	
Daily "	175.30	
Hourly "	457.65	
		1,137.45
Publications.		
Printing four bulletins	462.89	
Printing Annual Report	93.00	
Envelopes for bulletins and reports	85.00	
Illustrations, circulars, etc	115.34	
		756.23
Seeds, Plants and Sundry Supplies.		
Agricultural	74.28	
Horticultural	157.27	
Botanical	71.64	
Entomological	150.14	
Miscellaneous	117.87	
		571.20
Travelling Expenses.		
Supervision of Station work	34.51	
Other purposes connected with Station work	58.68	
		93.19
Buildings and Repairs.		
New Buildings	72.68	
Improvements	24.38	
		97.06
Postage and Stationery		221.47
Freight and Express		57.73
Chemical Supplies		10.37
Fertilizers		124.30
Furniture and Fixtures		30.50
Membership fee in A. A. A. C. & E. S		15.00
		$13,500.00

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the Cornell University Agricultural Experiment Station for the fiscal year ending June 30, 1904; that we have found the same well kept and classified as above, and that the receipts for the year from the Treasurer of the United States are shown to have been $13,500.00, and the corresponding disbursements $13,500.00; for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving no balance.

And we further certify that the expenditures have been solely for the purposes set forth in the Act of Congress approved March 2, 1887.

(Signed) R. B. WILLIAMS,
MYNDERSE VAN CLEEF,
Auditors.

(Seal)
Attest: EMMONS L. WILLIAMS,
Custodian.

BULLETINS, 1903–1904.

Herein are included Bulletins issued by the Federal Experiment Station for the year ending June 30, 1904, (Nos. 213, 214, 217, 220); and those issued under the auspices of the State Extension Fund for the year ending September 30, 1904, (Nos. 212, 215, 216, 218, 219, 221).

Aside from these regular Bulletins, the Experiment Station issued during the year Press Bulletins as follows: Anthracnose of the Grape, Keuka Grape Vines injured by winter. The Pear Psylla again destructive in New York Pear Orchards, Destructive Work of Plant-lice in New York Orchards, Insects Wanted, How to make Bordeaux Mixture. The College of Agriculture also continued to publish the Junior Naturalist Monthly, Home Nature-Study Course, Cornell Reading-Course for Farmers, Cornell Reading-Course for Farmers' Wives.

SEPTEMBER, 1903 BULLETIN 212

CORNELL UNIVERSITY
EXPERIMENT STATION OF
THE COLLEGE OF AGRICULTURE
Department of Animal Husbandry (Extension Work)

SECOND REPORT ON
COÖPERATIVE RECORDS OF THE
COST OF PRODUCING EGGS.

By **HENRY H. WING.**

ITHACA, N. Y.
PUBLISHED BY THE UNIVERSITY

ORGANIZATION

OF THE CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION.

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Office of the Director, 17 Morrill Hall.

The regular bulletins of the Station are sent free to persons residing in New York State who request them.

EXPERIMENT STATION, COLLEGE OF AGRICULTURE,
CORNELL UNIVERSITY, ITHACA, N. Y., Sept. 21, 1903.

HON. C. A. WIETING,
COMMISSIONER OF AGRICULTURE, ALBANY.

Sir:—I submit herewith a second and concluding Report on Coöperative Records of the Cost of Producing Eggs, being a record of the continuation of the work begun in 1901 and first reported in Bulletin 204. It has been the purpose to get at the average cost of eggs under the ordinary commercial conditions of actual poultry-raisers in different parts of the State, not to determine how much food must be consumed for the producing of a given number of eggs. We attacked a commercial question. This inquiry was completed under Professor Roberts' direction, and the present report terminates this stage of the poultry work. Having determined the nature of the variation in the cost of producing eggs, it now remains to discover more of the causes of these variations and to suggest means of increasing the efficiency of fowls.

In the first series of records, 1901–1902, more than 2,100 egg-laying fowls were under test, in the second, 1902–1903, more than 3,100, making altogether upwards of 5,200 birds that have been carefully watched and their performance recorded. These records are primarily of interest to the poultryman, although the general conclusions should appeal to the entire agricultural community.

A most instructive feature of these records is the immense range in the cost of producing eggs, a range that runs practically from six cents to six dollars the dozen. On examination, it is found that this remarkable range is not correlated closely with breed, character of building, or kind and quantity of food, although all these factors have an influence. One cause of this difference seems to be a difference in the hens themselves,—some hens are good layers and some poor layers, as some apple trees are good bearers and some poor bearers. What the reason is of this difference in what we call individuality, we do not know ; but it is probable that individual fowls may stamp their capabilities on their progeny as markedly as individual cows may transmit good or bad milking qualities. At all events, it is not sufficient that the poultryman pay attention to housing and feeding alone. He must also give attention to breeding, choosing hatching eggs from parents of known performance. This subject is now to be investigated.

The summary on page 47 shows that with all the 5,200 fowls, the average daily production during thirty-four weeks was one egg to nearly five birds. The average cost of all the eggs (151,615 in number) was about one and one-half cents each.

The extent of the poultry interests is very great. Poultry and eggs contribute to nearly every meal in nearly every household in the land. New York State was seventh in the value of poultry on June 1, 1900, being exceeded by Iowa, Illinois, Missouri, Ohio, Pennsylvania and Kansas. The value at that time was $4,310,755. The value of the poultry raised in the State for an entire year, 1899, was more than $6,000,000. In the census year, New York produced more than sixty-two million dozen eggs, or considerably more than 100 eggs for each inhabitant. In the value of its eggs, New York ranked fifth amongst the States. It is important that an industry as large as this should receive careful attention from investigators. It is also important that it receive attention on the part of teachers, because it affords opportunities for reaching great numbers of persons. Practically every farmer grows poultry; so do great numbers of residents in towns.

L. H. BAILEY,
Director.

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SECOND REPORT ON COÖPERATIVE RECORDS OF COST OF PRODUCING EGGS.

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COÖPERATIVE RECORDS OF THE COST OF PRODUCING EGGS.

Second and Concluding Report.

In Bulletin 204 there were published the results of a series of observations recording the amount of food consumed and number of eggs produced during the four winter months by a number of flocks of hens in different parts of the State. These observations were made in the winter of 1901–1902. The results seemed to be of sufficient interest and value to warrant a repetition of the observations in 1902–1903. Accordingly another series of observations has been made, duplicating as nearly as possible those of 1901–1902, and the results are published herewith. So far as possible the work of the two years has been combined and compared so as to base the averages and conclusions on the whole of the data so far obtained. The most notable difference in exterior conditions affecting the results is the lower price of eggs in 1902–1903.

I. DESCRIPTION OF THE FLOCKS.

The number of coöperators was about the same in the two years. The number of fowls was rather more in the second year. In 1902–3, 11 flocks and 3,131 hens and pullets participated. Several pens of the University flock were included. The coöperators were C. G. Brainard, Waterville; C. S. Menges. Yorktown; Mrs. Geo. E. Monroe, Dryden; Henry Turner, Myers; Alba A. Skinner, Greene; E. C. Stewart, Ithaca; and White & Rice, Yorktown; and to them thanks are due for cordial assistance and painstaking care in keeping the records.

No restrictions were placed upon the owners as to how the fowls were to be fed, cared for or managed. In brief, they were asked to produce, by their usual methods, the greatest possible number of eggs at the lowest possible cost and to report each week the kind and amount of food consumed and the number of eggs produced. From the reports so received the results in the following pages have been compiled. Occasional visits were made to each of the places and there is every reason to believe that the experiments were carefully conducted and the reports honestly and accurately made. The responsibility for accuracy in the records, however, must remain with the participants.

Following is a description of the flocks and the method of feeding. In order to avoid confusion with the flocks reported in Bulletin No. 204, the flocks in this bulletin are designated by the letters including and following the letter M.

Flock M.

This flock was composed of 500 White Leghorn pullets and 18 cocks and cockerels. During the course of the experiment 8 females died or were removed, leaving 492 at the close of the experiment. The owner furnishes the following statement of their care and feed: A dressing of cut straw from 2 in. to 3 in. deep, was kept in the pens. In this straw, early in the morning, enough wheat was scattered to satisfy the stock; no rule can be established as to amount, as sometimes the hens had a much keener appetite than at others, and experience alone governed the ration allowed. About 3 P. M., fowls were fed in troughs, all the cooked cut meat and bone the stock will eat quickly; if a few hens were noticed wiping their bills no more was fed, even though the ration was only half emptied. Usually from 5 to 10 minutes are required at this meal. Wheat is then scattered in the litter, same as in the morning, but much more liberally. Preferably some of the grains should remain undiscovered until the following morning, as this incites activity and searching, but not searching in vain.

Immediately after the morning wheat ration the water vessels, shell, grit and dust boxes are abundantly supplied, then a wire is driven through the head of a cabbage and it is hung so the hens can reach it easily from all sides.

Flock N.

This flock contained 520 White Leghorn pullets and 24 cockerels. Of the pullets, 13 died or were removed during the course of the experiment, leaving 507 at the close. This record did not begin till the week beginning Dec. 7, and is therefore one week shorter than the others.

The method of feeding was made as simple as possible to economize labor. The grain was fed about two hours before dark in about six inches of straw and enough given to keep the hens busy an hour or two in the morning when the mash was fed,—thus giving in affect three feeds a day. The vegetables, except cabbage, were given in the mash. The cabbages were hung so that the hens had to jump for them; this tended to limit the amount they would take and to supply exercise.

Flock O.

On Dec. 1 this flock contained 50 White Leghorn hens, 200 White Leghorn pullets and 10 cocks and cockerels; 10 more cockerels were added on Jan. 18. All the hens remained until the close of the experiment, but eight pullets died or were removed, leaving 192 at the close of the experiment.

The egg record of this flock was kept separately for the hens and pullets, but the feed was all weighed out together. It has been assumed that the hens and pullets ate the same amount per head and the food consumed has been divided pro rata. The hens in the report are designated as O–1, the pullets as O–2. In several other cases where the same practice was followed a similar designation has been used.

The general practice in feeding was as follows : As soon as the hens leave the roost a very light feed of grain, usually wheat, was given. This was followed with green food, then another light feed of grain. By dividing the morning portion in two feeds the fowls were kept active nearly all the forenoon. About 11 o'clock the mash feed was given. This was fed warm and the birds were allowed all they want. The afternoon feed was largely cracked corn. This is a liberal feed and was given soon enough to allow the birds to finish before dusk.

Flock P.

This flock contained on Dec. 1, 400 White Leghorn hens, 300 White Leghorn pullets and 21 cocks and cockerels. There were added on Jan. 11 20 pullets and one cockerel. During the experiment several pullets were sold and a considerable number of hens were slaughtered. There were removed from the experiment for all reasons 62 hens and 24 pullets, leaving at the close of the experiment 338 hens and 296 pullets. The hens are designated as P–1 the pullets as P–2.

The flock was fed three times a day, beginning with the mixed grain of corn, wheat, oats and buckwheat scattered in the straw or litter. The noon feed consisted of a mash fed hot in winter, made up of boiled and mashed vegetables, corn meal, wheat bran, wheat middlings, ground oats and animal meal. After this was eaten clean, they were given a ration of either fresh cut bone or sliced vegetables. At night they were fed all the mixed grain they would eat clean, with a little extra scattered in the litter for the early birds in the morning.

Flock Q.

This flock was composed of 56 White Leghorn hens, 93 White Leghorn pullets and 7 cocks and cockerels ; 2 hens and 6 pullets died or were removed during the experiment, leaving 54 hens and 87 pullets at the close. The hens are designated as Q–1 and the pullets as Q–2.

This flock was fed whole mixed grain in the litter morning and evening. Fresh vegetables and skimmed milk were fed in the middle of the day and during a part of the time a light mash was also given about noon.

Flock R.

This flock was composed of 43 Brown Leghorn pullets and 2 cockerels ; 9 died or were removed during the experiment, leaving 34 on hand at the close.

This flock was fed and cared for in all respects the same as flock Q.

Flock S.

At the beginning of the experiment this flock contained 69 Black Minorca hens and 25 Black Minorca pullets; 26 White Wyandotte hens and 13 pullets and 9 cocks and cockerels. There were removed in all, mostly by sales, 33 hens and pullets leaving 100 on hand at the close of the experiment.

The fowls were fed three times a day regularly, whole grain in the morning, mash at noon and whole grain at night; green food, including clover, was not fed in the mash, but at some time following a grain food, usually in the morning, occasionally in mid-afternoon.

Flock T.

This flock was composed of 14 Black Minorca hens, 15 Black Minorca pullets and 2 cockerels. One of the hens died during the course of the experiment. The pullets all remained till the close.

This flock was fed and cared for in all respects as flock Q.

The hens are designated as T–1, the pullets as T–2.

Flock W.

On Dec. 1 this flock contained 82 White Wyandotte hens and 96 White Wyandotte pullets; 70 White Leghorn hens; 55 crossbred White Leghorn × White Wyandotte hens; 63 Buff Leghorn pullets, 8 cocks and cockerels; 19 hens and 23 pullets were removed during the course of the experiment leaving 188 hens and 136 pullets at the close. The hens are designated as W–1, the pullets as W–2.

This flock was fed about 7:00 A. M., noon, and 5:00 P. M.; the time of the evening feed varied, being earlier in winter and later in summer. The morning and evening feeds consisted of whole grain; wheat, oats and corn mixed. The noon feed consisted of a mash composed of wheat bran, white middlings, corn meal, ground oats, meat meal and cut clover moistened to a crumbly consistency with skim milk or water, always the former when available. Aside from the clover, all green feed was fed about middle of forenoon. Oyster shells were always before them.

Flock X.

This flock consisted of 16 White Wyandotte hens; 13 Barred Plymouth Rock hens; 25 Barred Plymouth Rock pullets, and 3 cocks and cockerels; 2 hens and 4 pullets died or were removed, leaving 27 hens and 21 pullets at the close. The hens are designated as X–1, the pullets as X–2.

This flock was fed and cared for in all respects like flock Q.

Flock Y.

This flock contained on Dec. 14, 347 hens and pullets somewhat mixed, but nearly all White Leghorns, 40 Silver Wyandotte hens and pullets and 3 cocks and cockerels ; 26 died or were removed, leaving 361 females at the close of the experiment.

This flock was fed whole mixed grain in the morning scattered in the litter, whole grain again at noon and a mash at 3:30 P. M., with fresh ground meat and bone twice a week.

The records for this flock were not begun till Dec. 14, and the whole period is two weeks shorter than the others.

II. DETAILS OF FOOD CONSUMED AND EGGS PRODUCED.

The records were continued from Dec. 1, 1902, to Mar. 28, 1903, a period of seventeen weeks lacking one day. This time, as a matter of convenience in discussing the results, has been divided into three periods of four weeks each, and one of five weeks corresponding as nearly as may be with the calendar months as follows :

Period I.	Dec. 1–27, four weeks.
Period II.	Dec. 28–Jan. 31, five weeks.
Period III.	Feb. 1–28, four weeks.
Period IV.	Mar. 1–28, four weeks.

In only one or two cases were daily weighings of the food made. In general, a quantity of feed was weighed out, mixed and recorded, and the fowls fed from this until it was used up, when more was weighed out. For this reason it has not been possible to calculate the exact amount of food consumed in a given period, but the variation is never very great and the amount for the whole time is correct.

The cost of the foods has been reckoned from uniform prices, and the same as those used in Bulletin 204. These prices have been based as nearly as possible on the actual cost price to the consumer and are as follows :

	Per cwt.
Wheat	$1.45
Corn	1.30
Corn on ear	.80
Oats	1.75
Buckwheat	1.20
Wheat bran	1.15
Wheat middlings	1.15
Corn meal	1.35
Ground oats	1.75
Ground barley	1.38
Mixed feed	1.50
Buckwheat middlings	.95
Malt sprouts	1.00
Old process linseed oil meal	1.70
H. O. Poultry Food	1.50
Meat scrap	2.15
Fresh ground bone	1.00
Skimmed milk	.08½

	Per cwt.
Potatoes	.42
Apples	.42
Turnips	.28
Mangels	.25
Cabbage	.30
Clover hay	.35
Clover meal	.70

The fowls were credited for the eggs on the basis of the New York quotations. The prices are the highest quotations for fresh eggs taken from the weekly edition of the New York *Producers' Price Current* for the Saturday ending the week of the record. For purposes of comparison with the results of last year the quotations for the corresponding weeks have been placed side by side below :

	1901–2.	1902–3.	1901–2 Per doz.	1902–3 Per doz.
Week ending	Dec. 7,	Dec. 6	$ .29	$ .29
"	" 14,	" 13	.29	.29
"	" 21,	" 20	.36	.28
"	" 28,	" 27	.31	.28
"	Jan. 4,	Jan. 3	.32	.28
"	" 11,	" 10	.36	.31
"	" 18,	" 17	.30	.31
"	" 25,	" 24	.29	.25
"	Feb. 1,	" 31	.30	.24
"	" 8,	Feb. 7	.29	.24
"	" 15,	" 14	.30	.16
"	" 22,	" 21	.36½	.17½
"	Mar. 1,	" 28	.29½	.16½
"	" 8,	Mar. 7	.25	.19
"	" 15,	" 14	.16½	.19½
"	" 22,	" 21	.16½	.17½
"	" 29,	" 28	.15½	.15

It will be noticed that while the prices were very nearly the same at the beginning and end of the experiment in the two years, they were on the whole much lower in 1902–3 than 1901–2, and particularly so during the month of February. The price of food remaining the same or nearly so in both years, the profits are correspondingly low in 1902–3.

FLOCK M.

AMOUNT AND COST OF FOOD CONSUMED.

1st Period. Dec. 1–27 inclusive. Average number 499¼.

1843.5 lbs.	wheat	cost $26.73
706.5 "	fresh ground meat and bone	" 7.07
329.2 "	cabbage	" .99
	Total	$34.79

2d Period. Dec. 28–Jan. 31 inclusive. Average number 497⅓.

2470.2 lbs.	wheat	cost $35.82
1127.2 "	fresh ground meat and bone	" 11.27
455.5 "	cabbage	" 1.37
	Total	$48.46

3d Period. Feb. 1–28 inclusive. Average number 494.

1877.9 lbs.	wheat	cost	$27.23	
709.2 “	fresh ground meat and bone	“	7.09	
337.7 “	cabbage	“	1.01	
	Total		$35.33	

4th Period. Mar. 1–28 inclusive. Average number 493¼.

2235.9 lbs.	wheat	cost	$32.42	
786.3 “	fresh ground meat and bone	“	7.86	
48.2 “	cabbage	“	.14	
	Total		$40.42	
	Total for entire time			$159.00

NUMBER AND VALUE OF EGGS PRODUCED.

1st Period. Dec. 1–27 inclusive.

Dec. 1– 7,	389 eggs at	.29 per doz	$ 9.40	
“ 8–14,	549 “	.29 “	13.27	
“ 15–21,	633 “	.28 “	14.77	
“ 22–27,	658 “	.28 “	15.35	
Total			$52.79	

2d Period. Dec. 28–Jan. 31 inclusive.

Dec. 28–Jan. 3,	862 eggs at	.28 per doz	$20.11	
Jan. 4–10,	980 “	.31 “	25.32	
“ 11–17,	977 “	.31 “	25.24	
“ 18–24,	771 “	.25 “	16.06	
“ 25–31,	719 “	.24 “	14.38	
Total			$101.11	

3d Period. Feb. 1–28 inclusive.

Feb. 1– 7,	1064 eggs at	.24 per doz	$21.28	
“ 8–14,	1439 “	.16 “	19.19	
“ 15–21,	1839 “	.17½ “	26.82	
“ 22–28,	1987 “	.16½ “	27.32	
Total			$94.61	

4th Period. Mar. 1–28 inclusive.

Mar. 1– 7,	2194 eggs at	.19 per doz	$34.74	
“ 8–14,	2392 “	.19½ “	38.87	
“ 15–21,	2486 “	.17½ “	36.25	
“ 22–28,	2481 “	.15 “	31.01	
Total			$140.87	
Total for entire time				$389.38

SUMMARY FOR FLOCK M.

	Average number of hens.	Number of eggs produced.	Cost of food consumed.	Food cost of one dozen eggs.	Value of eggs.	Excess of value over cost of food. "Profit."
1st period	499¼	2229	$34.79	$.187	$ 52.79	$ 18.00
2d period..........	497⅕	4309	48.46	.135	101.11	52.65
3d period..........	494	6329	35.33	.067	94.61	59.28
4th period.........	493¼	9553	40.42	.051	140.87	100.45
Entire time.......	496	22420	159.00	.085	389.38	230.38

PER 100 FOWLS.

	Average number.	Eggs produced per day.	Cost of food consumed.	Profit.
1st period............	499¼	15.9	$6.97	$ 3.61
2d period............	497⅕	24.8	9.75	10.59
3d period............	494	45.8	7.15	12.00
4th period............	493¼	69.1	8.19	20.36
Entire time..........	496	38.	32.06	46.45

FLOCK N.

AMOUNT AND COST OF FOOD CONSUMED.

1st Period. Dec. 7–27 inclusive. Average number 519.

518.1	lbs. corn	cost	$ 6.74
581.4	" wheat	"	8.43
331.7	" oats	"	5.80
259.3	" corn meal	"	3.50
126.2	" wheat bran	"	1.45
189.7	" ground barley	"	2.62
96.	" meat scraps	"	2.06
78.5	" cabbage	"	.24
287.3	" mangels	"	.72
40.2	" clover hay	"	.14
	Total		$31.70

2d Period. Dec. 28–Jan. 31 inclusive. Average number 516⅕.

814.2	lbs. corn	cost	$ 10.58
907.5	" wheat	"	13.16
549.	" oats	"	9.61
340.8	" corn meal	"	4.60
182.5	" wheat bran	"	2.10
260.9	" ground barley	"	3.60
329.8	" meat scraps	"	7.09
335.4	" cabbage	"	1.01
528.3	" mangels	"	1.32
80.2	" clover hay	"	.28
	Total		$53.35

3d Period. Feb. 1–28 inclusive. Average number 513¼.

727.7 lbs.	corn	cost	$ 9.46	
807.7 “	wheat	“	11.71	
571.9 “	oats	“	10.01	
314.9 “	corn meal	“	4.25	
175.8 “	wheat bran	“	2.02	
244.1 “	ground barley	“	3.37	
166.3 “	meat scraps	“	3.58	
204.2 “	cabbage	“	.61	
268.4 “	mangels	“	.67	
107.4 “	clover hay	“	.38	
Total			$46.06	

4th Period. Mar. 1–28 inclusive. Average number 510.

677.8 lbs.	corn	cost	$ 8.81	
753.3 “	wheat	“	10.92	
564.8 “	oats	“	9.88	
233.1 “	corn meal	“	3.15	
124. “	wheat bran	“	1.43	
178.3 “	ground barley	“	2.46	
204.5 “	meat scraps	“	4.40	
385.8 “	cabbage	“	1.16	
268.4 “	mangels	“	.67	
161.1 “	clover hay	“	.56	
Total			$43.44	
Total for entire time				$174.55

NUMBER AND VALUE OF EGGS PRODUCED.

1st Period. Dec. 7–27 inclusive.

Dec. 7–13,	430	eggs at	.29	per doz.	$10.39
“ 14–20,	506	“	“ .28	“	11.81
“ 21–27,	826	“	“ .28	“	19.27
Total					$41.47

2d Period. Dec. 28–Jan. 31 inclusive.

Dec. 28–Jan. 3,	893	eggs at	.28	per doz.	$20.84
Jan. 4–10,	1009	“	“ .31	“	26.07
“ 11–17,	904	“	“ .31	“	23.45
“ 18–24,	748	“	“ .25	“	15.58
“ 25–31,	636	“	“ .24	“	12.72
Total					$98.66

3d Period. Feb. 1–28 inclusive.

Feb. 1– 7,	602	eggs at	.24	per doz.	$12.04
“ 8–14,	715	“	.16	“	9.51
“ 15–21,	857	“	.17½	“	12.50
“ 22–28,	1121	“	.16½	“	15.41
Total					$49.46

4th Period. Mar. 1–28 inclusive.

Mar. 1– 7,	1238	eggs at	.19	per doz.	$19.60	
“ 8–14,	1236	“	.19½	“	20.09	
“ 15–21,	1385	“	.17½	“	20.20	
“ 22–28,	1641	“	.15	“	20.51	
Total					$80.40	
Total for entire time.						$269.99

SUMMARY FOR FLOCK N.

	Average number of hens.	Number of eggs produced.	Cost of food consumed.	Food cost of one dozen eggs.	Value of eggs.	Excess of value over cost of food. "Profit."
* 1st period	519	1762	$ 31.70	$.216	$41.47	$ 9.77
2d period.........	516⅕	4190	53.35	.153	98.66	45.31
3d period	513¼	3295	46.06	.168	49.46	3.40
4th period.... ...	510	5500	43.44	.095	80.40	36.96
Entire time.......	514.7	14747	174.55	.142	261.99	95.44

PER 100 FOWLS.

	Average number.	Eggs produced per day.	Cost of food consumed.	Profit.
* 1st period	519	16.1	$ 6.11	$ 1.88
2d period	516⅕	23.2	10.34	8.78
3d period.............	513¼	22.9	8.97	.66
4th period	510	38.5	8.52	7.25
Entire time..........	514.7	24.1	33.91	18.54

* Three weeks only.

FLOCK O.

AMOUNT AND COST OF FOOD CONSUMED.

1st Period. Dec. 1-27 inclusive. Average number 249¾.

404.7 lbs.	corn	cost	$ 5.26
166.3 "	wheat...	"	2.41
72.1 "	oats...	"	1.26
69.2 "	buckwheat	"	.83
70.1 "	corn meal	"	.95
70.1 "	wheat bran...	"	.81
62.5 "	wheat middlings...	"	.72
54.8 "	ground oats	"	.96
23.2 "	linseed oil meal...	"	.39
118.2 "	meat scraps...	"	2.54
184.6 "	cabbage...	"	.55
100. "	beets	"	.25

Total...	$16.93
Total for Flock O–1, 50 hens.........................	3.39
Total for Flock O–2, 199¾ pullets.........................	13.54

2d Period. Dec. 28-Jan. 31 inclusive. Average number 247⅖.

306.2 lbs.	corn	cost	$ 3.98
327.6 "	wheat	"	4.75
222.2 "	oats	"	3.89
146.2 "	buckwheat	"	1.75
73.6 "	corn meal	"	.99
85.2 "	wheat bran	"	.98

60.4	lbs.	wheat middlings	cost	$ .69	
84.2	"	ground oats	"	1.47	
28.5	"	linseed oil meal	"	.48	
110.7	"	meat scraps	"	2.38	
209.	"	cabbage	"	.63	
141.8	"	beets	"	.35	
		Total		$22.34	
		Total for Flock O–1, 50 hens		4.51	
		Total for Flock O–2, 197⅗ pullets		17.83	

3d Period. Feb. 1–28 inclusive. Average number 244½.

251.5	lbs.	corn	cost	$ 3.27	
345.8	"	wheat	"	5.01	
173.1	"	oats	"	3.03	
37.9	"	buckwheat	"	.45	
66.4	"	corn meal	"	.90	
70.2	"	wheat bran	"	.81	
52.6	"	wheat middlings	"	.60	
66.4	"	ground oats	"	1.16	
22.	"	linseed oil meal	"	.37	
111.8	"	meat scraps	"	2.40	
274.5	"	cabbage	"	.82	
51.6	"	beets	"	.13	
		Total		$18.95	
		Total for Flock O–1, 50 hens		3.88	
		Total for Flock O–2, 194½ pullets		15.07	

4th Period. Mar. 1–28 inclusive. Average number 242¼.

193.1	lbs.	corn	cost	$ 2.51	
389.9	"	wheat	"	5.65	
166.4	"	oats	"	2.91	
13.	"	buckwheat	"	.16	
66.4	"	corn meal	"	.90	
66.4	"	wheat bran	"	.76	
22.2	"	wheat middlings	"	.26	
55.4	"	ground oats	"	.97	
16.5	"	linseed oil meal	"	.28	
110.8	"	meat scraps	"	2.38	
274.4	"	cabbage	"	.82	
37.8	"	beets	"	.09	
		Total		$17.69	
		Total for Flock O–1, 50 hens		3.65	
		Total for Flock O–2, 192¼ pullets		14.04	
		Total for entire time, Flock O–1			$15.69
		Total for entire time, Flock O–2			61.48
		Total for entire flock for entire time			77.17

FLOCK O–1.

NUMBER AND VALUE OF EGGS PRODUCED.

1st Period. Dec. 1–27 inclusive.

Dec.	1– 6,	54 eggs	at .29	per doz	$ 1.31
"	7–13,	35	" .29	"	.85
"	14–20,	19	" .28	"	.44
"	21–27,	27	" .28	"	.63
	Total				$ 3.23

2d Period. Dec. 28–Jan. 31 inclusive.

Dec. 28–Jan. 3,	27	eggs at .28 per doz	$ .63
Jan. 4–10,	31	" .31 "	.80
" 11–17,	25	" .31 "	.65
" 18–24,	27	" .25 "	.56
" 25–31,	39	" .24 "	.78
Total			$ 3.42

3d Period. Feb. 1–28 inclusive.

Feb. 1– 7,	58	eggs at .24 per doz	$1.16
" 8–14,	68	" .16 "	.91
" 15–21,	59	" .17½ "	.86
" 22–28,	47	" .16½ "	.65
Total			$3.58

4th Period. Mar. 1–28 inclusive.

Mar. 1– 7,	53	eggs at .19 per doz	$ .84	
" 8–14,	85	" .19½ "	1.38	
" 15–21,	155	" .17½ "	2.26	
" 22–28,	207	" .15 "	2.59	
Total			$7.07	
Total for entire time				$17.30

SUMMARY FOR FLOCK O–1.

	Average number of hens.	Number of eggs produced.	Cost of food consumed.	Food cost of one dozen eggs.	Value of eggs.	Excess of value over cost of food "Profit."
1st period	50	135	$3.39	$.301	$3.23	$— .16
2d period	50	149	4.51	.363	3.42	—1.09
3d period	50	232	3.88	.201	3.58	— .30
4th period	50	505	3.65	.087	7.07	3.42
Entire time	50	1021	15.43	.181	17.30	1.87

PER 100 FOWLS.

	Average number.	Eggs produced per day.	Cost of food consumed.	Profit.
1st period	50	9.6	$6.78	$— .32
2d period	50	8.5	9.02	—2.18
3d period	50	16.6	7.76	— .60
4th period	50	36.1	7.30	6.84
Entire time	50	17.2	30.86	3.74

FLOCK O-2.

NUMBER AND VALUE OF EGGS PRODUCED.

1st Period. Dec. 1-27 inclusive.

Dec. 1- 6, 111 eggs at .29 per doz		$ 2.68
" 7-13, 115 " .29 "		2.78
" 14-20, 102 " .28 "		2.38
" 21-27, 132 " .28 "		3.08
Total		$10.92

2d Period. Dec. 28-Jan. 31 inclusive.

Dec. 28-Jan. 3, 145 eggs at .28 per doz		$ 3.38
Jan. 4-10, 155 " .31 "		4.00
" 11-17, 133 " .31 "		3.44
" 18-24, 124 " .25 "		2.58
" 25-31, 178 " .24 "		3.56
Total		$16.96

3d Period. Feb. 1-28 inclusive.

Feb. 1- 7, 236 eggs at .24 per doz		$ 4.72
" 8-14, 291 " .16 "		3.88
" 15-21, 312 " .17½ "		4.55
" 22-28, 253 " .16½ "		3.48
Total		$16.63

4th Period. Mar. 1-28 inclusive.

Mar. 1- 7, 277 eggs at .19 per doz	$ 4.39	
" 8-14, 387 " .19½ "	5.29	
" 15-21, 596 " .17½ "	8.69	
" 22-28, 795 " .15 "	9.94	
Total	$28.31	
Total for entire time		$72.82

SUMMARY FOR FLOCK O-2.

	Average number of hens.	Number of eggs produced.	Cost of food consumed.	Food cost of one dozen eggs.	Value of eggs.	Excess of value over cost of food. "Profit."
1st period	199¾	460	$13.54	$.353	$10.92	$—2.62
2d period	197⅖	735	17.83	.291	16.96	— .87
3d period	194½	1092	15.07	.166	16.63	1.56
4th period	192¼	2055	14.04	.082	28.31	14.27
Entire time	196.1	4342	60.48	.167	72.82	12.34

PER 100 FOWLS.

	Average Number.	Eggs produced per day.	Cost of food consumed.	Profit.
1st period	199¾	8.2	$ 6.78	$ – 1.31
2d period	197⅖	10.6	9.03	— .44
3d period	194¼	20.1	7.75	.80
4th period	192¼	38.2	7.30	7.42
Entire time	196.1	18.6	30.84	6.29

FLOCK P.

AMOUNT AND COST OF FOOD CONSUMED.

1st Period. Dec. 1–27 inclusive. Average number 697½.

1087.2	lbs.	corn	cost	$14.14
1048.4	“	wheat	“	15.20
180.	“	corn meal	“	2.43
343.9	“	wheat bran	“	3.96
252.4	“	wheat middlings	“	2.90
66.6	“	ground oats	“	1.17
69.3	“	oil meal	“	1.18
174.5	“	meat scraps	“	3.75
48.5	“	cabbage	“	.14
417.4	“	turnips	“	1.17
194.4	“	potatoes	“	.82
		Total		$46.86
		Total for Flock P–1, 400 hens		$26.89
		Total for Flock P–2, 297½ pullets		$19.97

2d Period. Dec. 28–Jan. 31 inclusive. Average number 702⅖.

1678.4	lbs.	corn	cost	$21.81
1338.7	“	wheat	“	19.41
499.7	“	oats	“	8.75
227.3	“	corn meal	“	3.07
463.3	“	wheat bran	“	5.33
279.1	“	wheat middlings	“	3.21
181.8	“	ground oats	“	3.18
22.9	“	oil meal	“	.38
226.	“	meat scraps	“	4.86
63.1	“	fresh ground bone	“	.64
902.2	“	turnips	“	2.53
19.4	“	beets	“	.05
		Total		$73.22
		Total for Flock P–1, 400 hens		$41.70
		Total for Flock P–2, 302⅖ pullets		$31.52

3d Period. Feb. 1–28 inclusive. Average number 704.

1205.2	lbs.	corn	cost	$15.66
1168.8	“	wheat	“	16.94
392.	“	oats	“	6.86
174.7	“	corn meal	“	2.36

278.9	lbs.	wheat bran	cost	$ 3.20
244.4	"	wheat middlings	"	2.81
139.7	"	ground oats	"	2.45
162.5	"	meat scraps	"	3.50
737.1	"	turnips	"	2.06

Total	$55.84
Total for Flock P–1, 396 hens	$31.41
Total for Flock P–2, 308 pullets	$24.43

4th Period. Mar. 1–28 inclusive. Average number 686.

1073.3	lbs.	corn	cost	$13.95
1024.9	"	wheat	"	14.86
160.5	"	oats	"	2.81
140.6	"	corn meal	"	1.90
237.6	"	wheat bran	"	2.73
158.1	"	wheat middlings	"	1.82
112.7	"	ground oats	"	1.97
140.6	"	meat scraps	"	3.02
9.7	"	fresh ground bone	"	.09
623.5	"	turnips	"	1.75

Total	$44.90	
Total for Flock P–1, 383¾ hens	$25.12	
Total for Flock P–2, 302¼ pullets	$19.78	
Total for Flock P–1, 395⅕ hens		$125.12
Total for Flock P–2, 302½ pullets		$95.70
Total for entire flock entire time		$220.82

FLOCK P–1.

NUMBER AND VALUE OF EGGS PRODUCED.

1st Period. Dec. 1–27 inclusive.

Dec. 1– 6,	68	eggs at	.29	per doz	$1.64
" 7–14,	64	"	.29	"	1.55
" 15–20,	69	"	.28	"	1.61
" 21–27,	88	"	.28	"	2.05
Total					$ 6.85

2d Period. Dec. 28–Jan. 31 inclusive.

Dec. 28–Jan. 3,	119	eggs at	.28	per doz	$2.78
Jan. 4–10,	214	"	.31	"	5.53
" 11–17,	244	"	.31	"	6.30
" 18–24,	277	"	.25	"	5.77
" 24–31,	304	"	.24	"	6.08
Total					$26.46

3d Period. Feb. 1–28 inclusive.

Feb. 1– 7,	402	eggs at	.24	per doz	$ 8.04
" 8–14,	575	"	.16	"	7.67
" 15–21,	790	"	.17½	"	11.52
" 22–28,	740	"	.16½	"	10.18
Total					$37.41

4th Period. Mar. 1–28 inclusive.

Mar. 1– 7,	922 eggs at .19 per doz	$14.60	
" 8–14,	1173 " .19½ "	19.06	
" 15–21,	1220 " .17½ "	17.79	
" 22–28,	1414 " .15 "	17.68	
Total		$69.13	
Total for entire time			$139.85

SUMMARY FOR FLOCK P–1.

	Average number of hens.	Number of eggs produced.	Cost of food consumed.	Food cost of one dozen eggs.	Value of eggs.	Excess of value over cost of food "Profit."
1st period	400	289	$26.89	$1.117	$ 6.85	$—20.04
2d period	400	1158	41.70	.432	26.46	—15.24
3d period	396	2507	31.41	.150	37.41	6.00
4th period	383¾	4729	25.12	.064	69.13	44.01
Entire time	395¼	8683	125.12	.173	139.85	14.73

PER 100 FOWLS.

	Average number.	Eggs produced per day.	Cost of food consumed.	Profit.
1st period	400	2.6	$ 6.72	$—5.01
2d period	400	8.3	10.43	—3.81
3d period	396	22.6	7.93	1.52
4th period	383¾	44.	6.55	11.47
Entire time	395¼	18.5	31.66	3.73

FLOCK P–2.

NUMBER AND VALUE OF EGGS PRODUCED.

1st Period. Dec. 1–27 inclusive.

Dec. 1- 6,	92 eggs at .29 per doz	$ 2.22
" 7–14,	138 " .29 "	3.34
" 15–20,	168 " .28 "	3.92
" 21–27,	296 " .28 "	6.91
Total		$16.39

2d Period. Dec. 28–Jan. 31 inclusive.

Dec. 28–Jan. 3,	531 eggs at .28 per doz	$12.39
Jan. 4–10,	691 " .31 "	17.85
" 11–17,	674 " .31 "	17.41
" 18 24,	765 " .25 "	15.94
" 24–31,	804 " .24 "	16.08
Total		$79.67

3d Period. Feb. 1–28 inclusive.

Feb. 1– 7,	854 eggs at	.24 per doz	$17.08	
" 7–14,	1010 "	.16 "	13.47	
" 15–21,	1000 "	.17½ "	14.58	
" 22–28,	802 "	.16½ "	11.03	
Total			$56.16	

4th Period. Mar. 1–28 inclusive.

Mar. 1– 7,	977 eggs at	.19 per doz	$15.47	
" 8–14,	1224 "	.19½ "	19.89	
" 15–21,	1240 "	.17½ "	18.08	
" 22–28,	1024 "	.15 "	12.80	
Total			$66.24	
Total for entire time				$218.46

SUMMARY FOR FLOCK P–2.

	Average number of hens.	Number of eggs produced.	Cost of food consumed.	Food cost of one dozen eggs.	Value of eggs.	Excess of value over cost of food. "Profit."
1st period	297½	694	$19.97	$.345	$16.39	$ – 3.58
2d period	302⅔	3465	31.52	.109	79.67	48.15
3d period	308	3666	24.43	.080	56.16	31.73
4th period	302¼	4465	19.78	.053	66.24	46.46
Entire time	302½	12290	95.70	.093	218.46	122.76

PER 100 FOWLS.

	Average number.	Eggs produced per day.	Cost of food consumed.	Profit.
1st period	297½	8.1	$ 6.71	$— 1.20
2d period	302⅔	32.7	10.42	15.92
3d period	308	42.5	7.93	10.30
4th period	302¼	52.8	6.54	15.37
Entire time	302½	34.1	31.63	40.58

FLOCK Q.

AMOUNT AND COST OF FOOD CONSUMED.

1st Period. Dec. 1–27 inclusive. Average number 148¼.

141.3	lbs. corn	cost	$ 1.84
141.3	" wheat	"	2.05
141.3	" oats	"	2.47
141.3	" buckwheat	"	1.70
19.1	" corn meal	"	.26
19.1	" wheat middlings	"	.22

19.1 lbs.	ground oats	cost	$ .33
9.6 "	buckwheat middlings	"	.09
19.1 "	malt sprouts	"	.20
17.2 "	meat scraps	"	.37
17.2 "	oil meal	"	.29
157.4 "	skimmed milk	"	.13
268. "	beets	"	.67
	Total		$ 10.62
	Total for Flock Q-1, 56 hens		4.01
	Total for Flock Q-2, 92¼ pullets		6.61

2d Period. Dec. 28-Jan. 31 inclusive. Average number 146⅓.

288.1 lbs.	corn	cost	$ 3.75
341.6 "	wheat	"	4.95
341.6 "	oats	"	5.98
181.3 "	buckwheat	"	2.18
9.5 "	corn meal	"	.13
9.5 "	wheat middlings	"	.11
9.5 "	ground oats	"	.17
4.8 "	buckwheat middlings	"	.05
9.5 "	malt sprouts	"	.10
14.3 "	meat scraps	"	.31
205. "	skimmed milk	"	.17
257.1 "	beets	"	.64
	Total		$18.54
	Total for Flock Q-1, 55¼ hens		7.00
	Total for Flock Q-2, 91 pullets		11.54

3d Period. Feb. 1-28 inclusive. Average number 141¼.

236.2 lbs.	corn	cost	$ 3.07
354.5 "	wheat	"	5.14
354.5 "	oats	"	6.20
23.8 "	buckwheat	"	.29
19.1 "	corn meal	"	.26
19.1 "	wheat middlings	"	.22
19.1 "	ground oats	"	.33
9.5 "	buckwheat middlings	"	.09
19.1 "	malt sprouts	"	.20
28.6 "	meat scraps	"	.61
299.6 "	skimmed milk	"	.25
262.3 "	beets	"	.66
13.8 "	cabbage	"	.04
	Total		$17.36
	Total for Flock Q-1, 54 hens		6.64
	Total for Flock Q-2, 87¼ pullets		10.72

4th Period. Mar. 1-28 inclusive. Average number 141.

169.4 lbs.	corn	cost	$ 2.20
176.2 "	wheat	"	2.55
176.2 "	oats	"	3.08
28.9 "	buckwheat	"	.35
30.7 "	corn meal	"	.41
23. "	wheat bran	"	.26
23. "	wheat middlings	"	.26
30.7 "	ground oats	"	.54
30.7 "	meat scraps	"	.66
335.8 "	skimmed milk	"	.29

68.1 lbs. beets	cost $ .17	
302.2 " cabbage	" .91	
Total	$11.68	
Total for Flock Q-1, 54 hens	4.47	
Total lor Flock Q-2, 87 pullets	7.21	
Total for entire time, Flock Q-1, 54.8 hens		$ 22.12
Total for entire time, Flock Q-2, 89½ pullets		36.08
Total for entire flock entire time		58.20

FLOCK Q-1.

NUMBER AND VALUE OF EGGS PRODUCED.

1st Period. Dec. 1-27 inclusive.

Dec. 1- 6,	47 eggs at	.29	per doz	$ 1.14
" 7-13,	49 "	.29	"	1.18
" 14-20,	38 "	.28	"	.89
" 21-27,	38 "	.28	"	.89
Total				$ 4.10

2d Period. Dec. 28-Jan. 31 inclusive.

Dec. 28-Jan. 3,	36 eggs at	.28	per doz	$ .84
Jan. 4-10,	44 "	.31	"	1.14
" 11-17,	31 "	.31	"	.80
" 18-24,	33 "	.25	"	.69
" 25-31,	69 "	.24	"	1.38
Total				$ 4.85

3d Period. Feb. 1-28 inclusive.

Feb. 1- 7,	91 eggs at	.24	per doz	$ 1.82
" 8-14,	102 "	.16	"	1.36
" 15-21,	131 "	.17½	"	1.91
" 22-28,	157 "	.16½	"	2.16
Total				$ 7.25

4th Period. Mar. 1-28 inclusive.

Mar. 1- 7,	168 eggs at	.19	per doz	$ 2.66	
" 8 14,	194 "	.19½	"	3.15	
" 15-21,	198 "	.17½	"	2.89	
" 22-28,	194 "	.15	"	2.43	
Total				$11.13	
Total for entire time					$ 27.33

SUMMARY FOR FLOCK Q-1.

	Average number of hens.	Number of eggs produced.	Cost of food consumed.	Food cost of one dozen eggs.	Value of eggs.	Excess of value over cost of food. "Profit."
1st period	56	172	$4.01	$.280	$4.10	$ .09
2d period	55⅕	213	7.00	.394	4.85	—2.15
3d period	54	481	6.64	.166	7.25	.61
4th period	54	754	4.47	.071	11.13	6.66
Entire time	54.8	1620	22.12	.164	27.33	5.21

PER 100 FOWLS.

	Average number.	Eggs produced per day.	Cost of food consumed.	Profit.
1st period	56	10.9	$ 7.16	$ .16
2d period	55⅕	11.	12.68	—3.89
3d period	54	31.8	12.30	1.13
4th period	54	49.9	8.27	12.33
Entire time	54.8	24.8	40.36	9.51

FLOCK Q–2.

NUMBER AND VALUE OF EGGS PRODUCED.

1st Period. Dec. 1–27 inclusive.

Dec.	1– 6,	145 eggs at	.29 per doz	$ 3.50
"	7–13,	143 "	.29 "	3.46
"	14–20,	143 "	.28 "	3.34
"	21–27,	164 "	.28 "	3.83
Total				$14.13

2d Period. Dec. 28–Jan. 31 inclusive.

Dec.	28–Jan. 3,	173 eggs at	.28 per doz	$ 4.04
Jan.	4–10,	166 "	.31 "	4.29
"	11–17,	102 "	.31 "	2.64
"	18–24,	57 "	.25 "	1.19
"	25–31,	103 "	.24 "	2.06
Total				$14.22

3d Period. Feb. 1–28 inclusive.

Feb.	1– 7,	179 eggs at	.24 per doz	$ 3.58
"	8–14,	179 "	.16 "	2.39
"	15–21,	224 "	.17½ "	3.27
"	22–28,	258 "	.16½ "	3.55
Total				$12.79

4th Period. Mar. 1–28 inclusive.

Mar.	1– 7,	297 eggs at	.19 per doz	$ 4.70	
"	8–14,	285 "	.19½ "	4.63	
"	15–21,	268 "	.17½ "	3.91	
"	22–28,	303 "	.15 "	3.79	
Total				$17.03	
Total for entire time					$58.17

SUMMARY FOR FLOCK Q–2.

	Average number of hens.	Number of eggs produced.	Cost of food consumed.	Food cost of one dozen eggs.	Value of eggs.	Excess of value over cost of food "Profit."
1st period	92¼	595	$ 6.61	$.133	$14.13	$7.52
2d period	91	601	11.54	.23	14.22	2.68
3d period	87¼	840	10.72	.153	12.79	2.07
4th period	87	1153	7.21	.075	17.03	9.82
Entire time	89½	3189	36.08	.135	58.17	22.09

PER 100 FOWLS.

	Average number.	Eggs produced per day.	Cost of food consumed.	Profit.
1st period	92¼	23.	$ 7.17	$ 8.15
2d period	91	18.9	12.68	2.94
3d period	87¼	34.4	12.29	2.37
4th period	87	47.3	8.29	11.28
Entire time	89½	29.9	40.31	24.68

FLOCK R.

AMOUNT AND COST OF FOOD CONSUMED.

1st Period. Dec. 1–27 inclusive. Average number 42½.

35.3	lbs.	corn	cost	$ .46
35.3	"	wheat	"	.51
35.3	"	oats	"	.62
35.3	"	buckwheat	"	.42
9.6	"	corn meal	"	.13
9.6	"	wheat middlings	"	.11
9.6	"	ground oats	"	.17
4.8	"	buckwheat middlings	"	.05
9.6	"	malt sprouts	"	.10
8.6	"	oil meal	"	.15
8.6	"	meat scraps	"	.18
37.9	"	skimmed milk	"	.03
70.8	"	beets	"	.18
		Total		$3.11

2d Period. Dec. 28–Jan. 31 inclusive. Average number 37⅗.

55.8	lbs.	corn	cost	$ .73
70.1	"	wheat	"	1.02
70.1	"	oats	"	1.23
27.3	"	buckwheat	"	.33
52.8	"	skimmed milk	"	.04
77.4	"	beets	"	.19
		Total		$ 3.54

3d Period. Feb. 1–28 inclusive. Average number 35.

58.3	lbs.	corn	cost	$ .76
87.6	"	wheat	"	1.27
87.6	"	oats	"	1.53
9.5	"	corn meal	"	.13
9.5	"	wheat middlings	"	.11
9.5	"	ground oats	"	.17
4.7	"	buckwheat middlings	"	.04
9.5	"	malt sprouts	"	.10
88.1	"	skimmed milk	"	.07
94.5	"	beets	"	.24
3.8	"	cabbage	"	.01
		Total		$ 4.43

4th Period. Mar. 1–28 inclusive. Average number 34¼.

60.3	lbs.	corn	cost	$ .78	
62.3	"	wheat	"	.90	
62.3	"	oats	"	1.09	
18.9	"	buckwheat	"	.23	
15.1	"	corn meal	"	.20	
11.3	"	wheat bran	"	.13	
11.3	"	wheat middlings	"	.13	
15.1	"	ground oats	"	.26	
15.1	"	meat scraps	"	.32	
2.8	"	fresh ground bone	"	.03	
139.9	"	skimmed milk	"	.12	
27.6	"	beets	"	.07	
93.	"	cabbage	"	.28	
		Total		$ 4.54	
		Total for entire time			$15.62

NUMBER AND VALUE OF EGGS PRODUCED.

1st Period. Dec. 1–27 inclusive.

Dec.	1– 6,	24 eggs at	.29	per doz	$ .58
"	7–13,	21	" .29	"	.50
"	14–20,	21	" .28	"	.49
"	21–27,	21	" .28	"	.49
Total					$2.06

2d Period. Dec. 28–Jan. 31 inclusive.

Dec.	28–Jan. 3,	13 eggs at	.28	per doz	$ .30
Jan.	4–10,	10	" .31	"	.26
"	11–17,	7	" .31	"	.18
"	18–24,	9	" .25	"	.19
"	25–31,	21	" .24	"	.42
Total					$1.35

3d Period. Feb. 1–28 inclusive.

Feb.	1– 7,	48 eggs at	.24	per doz	$ .96
"	8–14,	68	" .16	"	.91
"	15–21,	72	" .17½	"	1.05
"	22–28,	85	" .16½	"	1.17
Total					$4.[illegible]9

4th Period. Mar. 1–28 inclusive.

Mar. 1– 7, 100 eggs at .19 per doz			$1.58	
" 8–14, 134	" .19½	"	2.18	
" 15–21, 127	" .17½	"	1.85	
" 22–28, 132	" .15	"	1.65	
Total			$7.26	
Total for entire time				$14.76

SUMMARY FOR FLOCK R.

	Average number of hens.	Number of eggs produced.	Cost of food consumed.	Food cost of one dozen eggs.	Value of eggs.	Excess of value over cost of food "Profit."
1st period	42½	87	$ 3.11	$ .429	$ 2.06	$—1.05
2d period	37⅗	60	3.54	.708	1.35	—2.19
3d period	35	273	4.43	.199	4.09	— .35
4th period	34¼	493	4.54	.110	7.26	2.72
Entire time	37.3	913	15.62	.205	14.76	— .87

PER 100 FOWLS.

	Average number.	Eggs produced per day.	Cost of food consumed.	Profit.
1st period	42½	7.3	$ 7.32	$—2.47
2d period	37⅗	4.6	9.39	—5.82
3d period	35	27.9	12.66	—1.00
4th period	34¼	51.4	13.25	7.94
Entire time	37.3	20.6	41.88	—2.33

FLOCK S.

AMOUNT AND COST OF FOOD CONSUMED.

1st Period. Dec. 1–27 inclusive. Average number 133.

86.7	lbs. corn	cost	$1.13
43.3	" wheat	"	.63
43.3	" oats	"	.76
43.3	" buckwheat	"	.52
47.2	" corn meal	"	.64
43.6	" wheat bran	"	.50
35.2	" ground oats	"	.62
3.	" linseed oil meal	"	.05
30.	" fresh ground bone	"	.30
40.4	" skimmed milk	"	.03
81.2	" cabbage	"	.25
26.2	" beets	"	.07
31.5	" clover meal	"	.22
10.	" clover hay	"	.04
	Total		$5.76

2d Period. Dec. 28–Jan. 31 inclusive. Average number 120$\frac{3}{5}$.

205.4	lbs.	corn	cost $	2.67
148.6	"	wheat	"	2.15
209.9	"	oats	"	3.67
148.6	"	buckwheat	"	1.78
58.1	"	corn meal	"	.78
53.7	"	wheat bran	"	.62
43.4	"	ground oats	"	.76
50.4	"	fresh ground bone	"	.50
209.8	"	cabbage	"	.63
349.1	"	beets	"	.87
70.	"	turnips	"	.20
30.	"	clover meal	"	.21
20.3	"	clover hay	"	.07
		Total		$14.91

3d Period. Feb. 1–28 inclusive. Average number 115.

87.8	lbs.	corn	cost $	1.14
170.2	"	wheat	"	2.47
325.4	"	oats	"	5.69
87.8	"	buckwheat	"	1.05
43.6	"	corn meal	"	.59
40.4	"	wheat bran	"	.46
32.8	"	ground oats	"	.57
75.1	"	fresh ground bone	"	.75
31.6	"	skimmed milk	"	.03
242.	"	cabbage	"	.73
497.3	"	beets	"	1.24
10.7	"	clover meal	"	.07
131.7	"	clover hay	"	.46
		Total		$15.25

4th Period. Mar. 1–28 inclusive. Average number 105½.

102.	lbs.	corn	cost $	1.33	
204.1	"	wheat	"	2.96	
408.1	"	oats	"	7.14	
102.	"	buckwheat	"	1.22	
43.5	"	corn meal	"	.59	
40.	"	wheat bran	"	.46	
32.5	"	ground oats	"	.57	
69.2	"	fresh ground bone	"	.69	
90.1	"	skimmed milk	"	.08	
25.4	"	cabbage	"	.76	
465.5	"	beets	"	1.16	
4.2	"	clover meal	"	.03	
57.2	"	clover hay	"	.20	
		Total		$1 .19	
		Total for entire time			$53.11

NUMBER AND VALUE OF EGGS PRODUCED.

1st Period. Dec. 1–27 inclusive.

Dec.	1– 6,	27	eggs at	.29	per doz	$ .65
"	7–13,	41	"	.29	"	.99
"	14–20,	35	"	.28	"	.82
"	21–27,	53	"	.28	"	1.24
Total						$3.70

2d Period. Dec. 28–Jan. 31.

Dec. 28–Jan. 3,	64 eggs at	.28 per doz	$1.49
Jan. 4–10,	70 “	.31 “	1.81
“ 11–17,	48 “	.31 “	1.24
“ 18–24,	44 “	.25 “	.92
“ 25–31,	89 “	.24 “	1.78
Total			$7.24

3d Period. Feb. 1–28 inclusive.

Feb. 1– 7,	158 eggs at	.24 per doz	$3.16
“ 8–14,	222 “	.16 “	2.96
“ 15–21,	250 “	.17½ “	3.65
“ 22–28,	237 “	.16½ “	3.26
Total			$13.03

4th Period. Mar. 1–28 inclusive.

Mar. 1– 7,	272 eggs at	.19 per doz	$4.31	
“ 8–14,	299 “	19½ “	4.86	
“ 15–21,	365 “	17½ “	5.32	
“ 22–28,	466 “	15 “	5.83	
Total			$20.32	
Total for entire time				$44.29

SUMMARY FOR FLOCK S.

	Average number of hens.	Number of eggs produced.	Cost of food consumed.	Food cost of one dozen eggs.	Value of eggs.	Excess of value over cost of food “ Profit.”
1st period	133	156	$ 5.76	$ .443	$ 3.70	$—2.06
2d period	120⅗	315	14.91	.568	7.24	—7.67
3d period	115	867	15.25	.211	13.03	—2.22
4th period	105½	1402	17.19	.147	20.32	3.13
Entire time	118.6	2740	53.11	.233	44.29	—8.82

PER 100 FOWLS.

	Average number.	Eggs produced per day.	Cost of food consumed.	Profit.
1st period	133	4.2	$ 4.33	$—1.55
2d period	120⅗	7.5	12.36	—6.36
3d period	115	26.9	13.26	—1.93
4th period	105½	47.5	16.29	2.97
Entire time	118.6	19.4	44.78	—7.44

FLOCK T.

AMOUNT AND COST OF FOOD CONSUMED.

1st Period. Dec. 1–27 inclusive. Average number 29.

40.4	lbs. corn	cost $	.53
40.4	" wheat	"	.59
40.4	" oats	"	.71
40.4	" buckwheat	"	.48
9.7	" corn meal	"	.13
9.7	" wheat middlings	"	.11
9.7	" ground oats	"	.17
4.8	" buckwheat middlings	"	.05
9.7	" malt sprouts	"	.10
8.7	" oil meal	"	.15
8.7	" meat scraps	"	.19
14.4	" skimmed milk	"	.01
81.	" beets	"	.20
	Total	$	3.42
	Total for Flock T–1, 14 hens		1.65
	Total for Flock T–2, 15 pullets		1.77

2d Period. Dec. 28–Jan. 31 inclusive. Average number 28⅔.

59.7	lbs. corn	cost $	.78
71.1	" wheat	"	1.03
71.1	" oats	"	1.24
36.6	" buckwheat	"	.44
32.7	" skimmed milk	"	.03
78.7	" beets	"	.20
	Total	$	3.72
	Total for Flock T–1, 13⅔ hens		1.76
	Total for Flock T–2, 15 pullets		1.96

3d Period. Feb. 1–28 inclusive. Average number 28.

47.1	lbs. corn	cost $	.61
77.6	" wheat	"	1.13
77.6	" oats	"	1.36
9.7	" corn meal	"	.13
9.7	" wheat middlings	"	.11
9.7	" ground oats	"	.17
4.8	" buckwheat middlings	"	.05
9.7	" malt sprouts	"	.10
14.5	" meat scraps	"	.31
53.	" skimmed milk	"	.05
82.	" beets	"	.21
3.6	" cabbage	"	.01
	Total	$	4.24
	Total for Flock T–1, 13 hens		1.97
	Total for Flock T–2, 15 pullets		2.27

4th Period. Mar. 1–28 inclusive. Average number 28.

45.6	lbs. corn	cost $	.59
46.9	" wheat	"	.68
46.9	" oats	"	.82
14.5	" buckwheat	"	.17
11.6	" corn meal	"	.16
8.7	" wheat bran	"	.10

11.6 lbs.	wheat middlings	cost	$ .13	
11.6 "	ground oats	"	.20	
8.7 "	meat scraps	"	.19	
1.9 "	fresh ground bone	"	.02	
91.7 "	skimmed milk	"	.08	
21. "	beets	"	.05	
73.4 "	cabbage	"	.22	
	Total		$ 3.41	
	Total for Flock T–1, 13 hens		1.58	
	Total for Flock T–2, 15 pullets		1.83	
	Total for entire time, Flock T–1, 13.3 hens			$ 6.96
	Total for entire time, Flock T–2, 15 pullets			7.83
	Total for entire flock, entire time			14.79

FLOCK T–1.

NUMBER AND VALUE OF EGGS PRODUCED.

1st Period. Dec. 1–27 inclusive.

Dec. 1– 6,	8 eggs at	.29 per doz	$ .19	
" 7–13,	7 "	.29 "	.17	
" 14–20,	5 "	.28 "	.12	
" 21–27,	3 "	.28 "	.07	
Total			$ .55	

2d Period. Dec. 28–Jan. 31 inclusive.

Dec. 28–Jan. 3,	4 eggs at	.28 per doz	$ .09	
Jan. 4–10,	4 "	.31 "	.10	
" 11–17,	6 "	.31 "	.16	
" 18–24,	5 "	.25 "	.10	
" 25–31,	3 "	.24 "	.06	
Total			$ .51	

3d Period. Feb. 1–28 inclusive.

Feb. 1– 7,	4 eggs at	.24 per doz	$ .08	
" 8–14,	18 "	.16 "	.24	
" 15–21,	22 "	.17½ "	.32	
" 22–28,	21 "	.16½ "	.29	
Total			$ .93	

4th Period. Mar. 1–28 inclusive.

Mar. 1– 7,	31 eggs at	.19 per doz	$ .49	
" 8–14,	36 "	.19½ "	.59	
" 15–21,	37 "	.17½ "	.54	
" 22–28,	47 "	.15 "	.59	
Total			$2.21	
Total for entire time				$ 4.20

SUMMARY FOR FLOCK T-1.

	Average number of hens.	Number of eggs produced.	Cost of food consumed.	Food cost of one dozen eggs.	Value of eggs.	Excess of value over cost of food. "Profit."
1st period	14	23	$1.65	$.861	$ .55	$ 1.10
2d period	13⅖	22	1.76	.96	.51	—1.25
3d period..............	13	65	1.97	.364	.93	—1.04
4th period	13	151	1.58	.125	2.21	.63
Entire time	13.4	26.1	6.96	.32	4.20	—2.76

PER 100 FOWLS.

	Average number.	Eggs produced per day.	Cost of food consumed.	Profit.
1st period	14	5.9	$11.79	$—7.86
2d period	13⅖	4.7	13.13	—9.33
3d period	13	17.9	15.15	—8.00
4th period............	13	41.5	12.15	4.85
Entire time	13.4	16.3	51.94	—20.60

FLOCK T-2.

NUMBER AND VALUE OF EGGS PRODUCED.

1st Period. Dec. 1-27 inclusive.

Dec. 1- 6,	3 eggs at	.29 per doz	$ .07
" 7-13,	4 "	.29 "	.10
" 14-20,	2 "	.28 "	.05
" 21-27,	10 "	.28 "	.23
Total			$ .45

2d Period. Dec. 28-Jan 31 inclusive.

Dec. 28-Jan 3,	6 eggs at	.28 per doz	$ .14
Jan. 4-10,	5 "	.31 "	.13
" 11-17,	12 "	.31 "	.31
" 18-24,	6 "	.25 "	.13
" 25-31,	5 "	.24 "	.10
Total			$ .51

3d Period. Feb. 1-28 inclusive.

Feb. 1- 7,	10 eggs at	.24 per doz.........................	$ .20
" 8-14,	10 "	.16 "	.13
" 15-21,	28 "	.17½ "	.41
" 22-28,	35 "	.16½ "	.48
Total			$1.22

4th Period. Mar. 1-28 inclusive.

Mar. 1- 7, 38 eggs at .19 per doz	$ .60	
" 8-14, 38 " .19½ "	.62	
" 15-21, 29 " .17½ "	.42	
" 22-28, 52 " .15 "	.65	
Total	$2.29	
Total for entire time		$ 4.47

SUMMARY FOR FLOCK T-2.

	Average number of hens.	Number of eggs produced.	Cost of food consumed.	Food cost of one dozen eggs.	Value of eggs.	Excess of value over cost of food. "Profit."
1st period	15	19	$1.77	$1.12	$ .45	$—1.32
2d period	15	34	1.96	.692	.51	—1.45
3d period	15	83	2.27	.328	1.22	—1.05
4th period	15	157	1.83	.14	2.29	.46
Entire time	15	293	7.83	.321	4.47	—3.36

PER 100 FOWLS.

	Average number.	Eggs produced per day.	Cost of food consumed.	Profit.
1st period	15	4.5	$11.80	$—8.80
2d period	15	6.5	13.07	—9.67
3d period	15	19.8	15.13	—7.00
4th period	15	37.4	12.20	3.07
Entire time	15	16.4	52.20	—22.40

FLOCK W.

AMOUNT AND COST OF FOOD CONSUMED.

1st Period. Dec. 1-27 inclusive. Average number 364¾.

753.4	lbs. corn	cost	$9.79
417.7	" wheat	"	6.06
268.4	" oats	"	4.70
208.8	" buckwheat	"	2.51
45.6	" corn meal	"	.62
45.6	" wheat bran	"	.52
45.6	" wheat middlings	"	.52
36.5	" ground oats	"	.64
10.	" linseed oil meal	"	.17
22.7	" meat scraps	"	.49
318.4	" skimmed milk	"	.27
56.7	" beets	"	.14
60.7	" potatoes	"	.25
39.8	" clover hay	"	.14
	Total		$26.82
	Total for Flock W-1, 205¾ hens		15.13
	Total for Flock W-2, 159 pullets		11.69

2d Period. Dec. 28–Jan. 31 inclusive. Average number 361⅗.

959.6	lbs.	corn	cost	$12.47
577.7	"	wheat	"	8.38
384.	"	oats	"	6.72
223.4	"	buckwheat	"	2.68
106.6	"	corn meal	"	1.44
106.6	"	wheat bran	"	1.23
120.2	"	wheat middlings	"	1.38
85.3	"	ground oats	"	1.49
51.7	"	meat scraps	"	1.11
361.7	"	skimmed milk	"	.31
113.5	"	beets	"	.28
56.8	"	clover hay	"	.20
		Total		$37.69
		Total for Flock W-1, 203⅕ hens		21.18
		Total for Flock W-2, 158⅖ pullets		16.51

3d Period. Feb. 1–28 inclusive. Average number 349.

756	lbs.	corn	cost	$ 9.83
594.9	"	wheat	"	8.63
366.9	"	oats	"	6.42
105.2	"	corn meal	"	1.42
105.2	"	wheat bran	"	1.21
147.5	"	wheat middlings	"	1.70
84.	"	ground oats	"	1.47
63.	"	meat scraps	"	1.35
299.1	"	skimmed milk	"	.25
47.7	"	clover hay	"	.17
		Total		$32.45
		Total for Flock W-1, 198½ hens		18.46
		Total for Flock W-2, 150½ pullets		13.99

4th Period. Mar. 1–28 inclusive. Average number 333¾.

407.2	lbs.	corn	cost	$ 5.29	
755.9	"	wheat	"	10.96	
325.9	"	oats	"	5.70	
96.1	"	corn meal	"	1.30	
96.1	"	wheat bran	"	1.11	
135.4	"	wheat middlings	"	1.56	
76.8	"	ground oats	"	1.34	
48.3	"	meat scraps	"	1.04	
352.8	"	skimmed milk	"	.30	
55.8	"	clover hay	"	.20	
		Total		$ 28.80	
		Total for Flock W-1, 191¼ hens		16.50	
		Total for Flock W-2, 142½ pullets		12.30	
		Total for entire time, Flock W-1, 200 hens			$ 71.27
		Total for entire time, Flock W-2, 153 pullets			54.49
		Total for entire flock, entire time			125.76

FLOCK W-1.

NUMBER AND VALUE OF EGGS PRODUCED.

1st Period. Dec. 1–28 inclusive.

Dec.	1– 7,	58 eggs at	.29 per doz	$ 1.40
"	8–14,	70	" .29 "	1.69
"	15–21,	44	" .28 "	1.03
"	22–28,	58	" .28 "	1.35
	Total			$ 5.47

2d Period. Dec. 29–Feb. 1 inclusive.

Dec. 29–Jan. 4,	66 eggs	at .28 per doz	$ 1.54
Jan. 5–11,	95	“ .31 “	2.45
“ 12–18,	104	“ .31 “	2.69
“ 19–25,	100	“ .25 “	2.08
“ 26–Feb. 1,	144	“ .24 “	2.88
Total			$11.64

3d Period. Feb. 2–Mar. 1 inclusive.

Feb. 2– 8,	213 eggs	at .24 per doz	$4.26
“ 9–15,	253	“ .16 “	3.37
“ 16–22,	320	“ .17½ “	4.67
“ 23–Mar. 1,	379	“ .16½ “	5.21
Total			$17.51

4th Period. Mar. 2–29 inclusive.

Mar. 2– 8,	545 eggs	at .19 per doz	$ 8.63	
“ 9–15,	643	“ .19½ “	10.45	
“ 16–22,	719	“ .17½ “	10.49	
“ 23–29,	753	“ .15 “	9.41	
Total			38.98	
Total for entire time				$73.60

SUMMARY FOR FLOCK W–1.

	Average number of hens.	Number of eggs produced.	Cost of food consumed.	Food cost of one dozen eggs.	Value of eggs.	Excess of value over cost of food. “Profit.”
1st period	205¾	230	$15.13	$ .789	$ 5.47	$— 9.66
2d period	203⅓	509	21.18	.499	11.64	— 9.54
3d period	198½	1165	18.46	.19	17.51	— .95
4th period	191¼	2660	16.50	.074	38.98	22.48
Entire time	200	4564	71.27	.187	73.60	2.33

PER 100 FOWLS.

	Average number.	Eggs produced per day.	Cost of food consumed.	Profit.
1st period	205¾	4.	$ 7.35	$— 4.70
2d period	203⅓	7.2	10.42	— 4.69
3d period	198½	21.	9.30	— .48
4th period	191¼	49.7	8.62	11.75
Entire time	200	19.2	35.64	1.17

FLOCK W-2.

NUMBER AND VALUE OF EGGS PRODUCED.

1st Period. Dec. 1–28 inclusive.

Dec. 1– 7,	201 eggs at	.29	per doz	$ 4.86
" 8–14,	247 "	.29	"	5.97
" 15–21,	304 "	.28	"	7.09
" 22–28,	332 "	.28	"	7.75
Total				$25.67

2d Period. Dec. 29–Feb. 1 inclusive.

Dec. 29–Jan. 4,	317 eggs at	.28	per doz	$ 7.40
Jan. 5–11,	322 "	.31	"	8.32
" 12–18,	327 "	.31	"	8.45
" 19–25,	320 "	.25	"	6.67
" 26–Feb. 1,	353 "	.24	"	7.06
Total				$37.90

3d Period. Feb. 2–Mar. 1 inclusive.

Feb. 2– 8,	361 eggs at	.24	per doz	$ 7.22
" 9–15,	332 "	.16	"	4.43
" 16–22,	359 "	.17½	"	5.24
" 23–Mar. 1,	372 "	.16½	"	5.12
Total				$22.01

4th Period. Mar. 2–29 inclusive.

Mar. 2– 8,	492 eggs at	.19	per doz	$ 7.79	
" 9–15,	560 "	.19½	"	9.10	
" 16–22,	563 "	.17½	"	8.21	
" 23–29,	599 "	.15	"	7.49	
Total				$32.59	
Total for entire time					$118.17

SUMMARY FOR FLOCK W-2.

	Average number of hens.	Number of eggs produced.	Cost of food consumed.	Food cost of one dozen eggs.	Value of eggs.	Excess of value over cost of food "Profit."
1st period	159	1084	$11.69	$.139	$25.67	$13.98
2d period	158⅖	1639	16.51	.121	37.90	21.39
3d period	150½	1424	13.99	.118	22.01	8.02
4th period	142½	2214	12.30	.067	32.59	20.29
Entire time	153	6361	54.49	.102	118.21	63.68

PER 100 FOWLS.

	Average number.	Eggs produced per day.	Cost of food consumed.	Profit.
1st period	159	24.3	$ 7.35	$ 8.79
2d period	158⅖	29.6	10.42	13.45
3d period	150½	33.8	9.30	5.33
4th period	142½	55.5	8.63	14.24
Entire time	153	34.9	35.61	41.62

FLOCK X.

AMOUNT AND COST OF FOOD CONSUMED.

1st Period. Dec. 1–27 inclusive. Average number 52.

75.3	lbs.	corn	cost $ .98
75.3	"	wheat	" 1.09
75.3	"	oats	" 1.32
75.3	"	buckwheat	" .90
9.5	"	corn meal	" .13
9.5	"	wheat middlings	" .11
9.5	"	ground oats	" .17
4.7	"	buckwheat middlings	" .04
9.5	"	malt sprouts	" .10
8.5	"	meat scraps	" .18
8.5	"	oil meal	" .15
61.5	"	skimmed milk	" .05
162.4	"	beets	" .41

Total	$5.63
Total for Flock X–1, 28¼ hens	3.06
Total for Flock X–2, 23¾ pullets	2.57

2d Period. Dec. 28–Jan. 31 inclusive. Average number 51.

105.4	lbs.	corn	cost $ 1.37
127.	"	wheat	" 1.84
127.	"	oats	" 2.22
62.8	"	buckwheat	" .75
9.4	"	corn meal	" .13
9.4	"	wheat middlings	" .11
9.4	"	ground oats	" .16
4.7	"	buckwheat middlings	" .04
9.4	"	malt sprouts	" .10
14.2	"	meat scraps	" .31
128.3	"	skimmed milk	" .11
169.4	"	beets	" .42

Total	$ 7.56
Total for Flock X–1, 27⅗ hens	4.09
Total for Flock X–2, 23⅖ pullets	3.47

3d Period. Feb. 1–28 inclusive. Average number 49.

68.5	lbs.	corn	cost $ .89
111.2	"	wheat	" 1.61
111.2	"	oats	" 1.95
18.8	"	corn meal	" .25
18.8	"	wheat middlings	" .22

18.8 lbs.	ground oats	cost	$ .33
9.4 “	buckwheat middlings	“	.09
18.8 “	malt sprouts	“	.20
28.4 “	meat scraps	“	.61
233.7 “	skimmed milk	“	.20
144.9 “	beets	“	.36
4.8 “	cabbage	“	.01

Total	$ 6.72
Total for Flock X–1, 27 hens	3.70
Total for Flock X–2, 22 pullets	3.02

4th Period. Mar. 1–28 inclusive. Average number 48.

62.2 lbs.	corn	cost	$ .81
65.9 “	wheat	“	.96
65.9 “	oats	“	1.15
22.6 “	buckwheat	“	.27
14.8 “	corn meal	“	.20
11.3 “	wheat bran	“	.13
11.3 “	wheat middlings	“	.13
14.8 “	ground oats	“	.26
14.8 “	meat scraps	“	.32
5.6 “	fresh ground bone	“	.06
182.1 “	skimmed milk	“	.15
35.1 “	beets	“	.09
109.7 “	cabbage	“	.33

Total	$ 4.86	
Total for Flock X–1, 27 hens	2.73	
Total for Flock X–2, 21 pullets	2.13	
Total for entire time, Flock X–1, 27½ hens		$ 13.58
Total for entire time, Flock X–2, 22.6 pullets		11.19
Total for entire flock, entire time		24.87

FLOCK X–1.

NUMBER AND VALUE OF EGGS PRODUCED.

1st Period. Dec. 1–27 inclusive.

Dec. 1– 6,	30 eggs at	.29	per doz	$ .73
“ 7–13,	28	.29	“	.68
“ 14–20,	20	.28	“	.47
“ 21–27,	16	.28	“	.37
Total				$2.25

2d Period. Dec. 28–Jan. 31 inclusive.

Dec. 28–Jan. 3,	12 eggs at	.28	per doz	$ .28
Jan. 4–10,	13	.31	“	.34
“ 11–17,	16	.31	“	.41
“ 18–24,	14	.25	“	.29
“ 25–31,	18	.24	“	.36
Total				$ 1.68

3d Period. Feb. 1–28 inclusive.

Feb. 1– 7,	27 eggs at	.24	per doz	$ .54
“ 8–14,	45	.16	“	.60
“ 15–21,	47	.17½	“	.69
“ 22–28,	45	.16½	“	.62
Total				$2.45

4th Period. Mar. 1–28 inclusive.

Mar. 1– 7, 53	eggs at	.19 per doz	$ .84	
" 8–14, 60	"	.19½ "	.98	
" 15–21, 46	"	.17½ "	.67	
" 22–28, 54	"	.15 "	.68	
Total			$3.17	
Total for entire time				$9.55

SUMMARY FOR FLOCK X–1.

	Average number of hens.	Number of eggs produced.	Cost of food consumed.	Food cost of one dozen eggs.	Value of eggs.	Excess of value over cost of food. "Profit."
1st period	28¼	94	$ 3.06	$.391	$2.25	$— .81
2d period	27⅗	73	4.09	.672	1.68	—2.41
3d period	27	164	3.70	.271	2.45	—1.25
4th period	27	213	2.73	.154	3.17	.44
Entire time	27½	544	13.58	.30	9.55	—4.03

PER 100 FOWLS.

	Average number.	Eggs produced per day.	Cost of food consumed.	Profit.
1st period	28¼	11.9	$10.83	$—2.87
2d period	27⅗	7.6	14.82	—8.73
3d period	27	21.7	13.70	—4.63
4th period	27	28.2	10.11	1.63
Entire time	27½	16.6	49.38	—14.65

FLOCK X–2.

NUMBER AND VALUE OF EGGS PRODUCED.

1st Period. Dec. 1–27 inclusive.

Dec. 1– 6, 45	eggs at	.29 per doz	$ 1.09
" 7–13, 51	"	.29 "	1.23
" 14–20, 36	"	.28 "	.84
" 21–27, 39	"	.28 "	.91
Total			$ 4.07

2d Period. Dec. 28–Jan. 31 inclusive.

Dec. 28–Jan. 3,	33	eggs at	.28 per doz	$ .77
Jan. 4–10,	32	"	.31 "	.83
" 11–17,	9	"	.31 "	.23
" 18–24,	8	"	.25 "	.19
" 25–31,	17	"	.24 "	.34
Total				$ 2.36

3d Period. Feb. 1–28 inclusive.

Feb.	1– 7, 30	eggs at .24 per doz	$ .60	
"	8–14, 74	" .16 "	.99	
"	15–21, 78	" .17½ "	1.14	
"	22–28, 52	" .16½ "	.72	
Total			$ 3.45	

4th Period. Mar. 1–28 inclusive.

Mar.	1– 7, 72	eggs at .19 per doz	$ 1.14	
"	8–14, 88	" .19½ "	1.43	
"	15–21, 81	" .17½ "	1.18	
"	22–28, 82	" .15 "	1.03	
Total			$ 4.78	
Total for entire time				$14.66

SUMMARY FOR FLOCK X–2.

	Average number of hens.	Number of eggs produced.	Cost of food consumed.	Food cost of one dozen eggs.	Value of eggs.	Excess of value over cost of food. "Profit."
1st period	23¾	171	$2.57	$.18	$4.07	$1.50
2d period	23⅔	99	3.47	.421	2.36	—1.11
3d period	22	234	3.02	.155	3.45	.43
4th period	21	323	2.13	.079	4.78	2.65
Entire time	22.6	827	11.19	.162	14.66	3.47

PER 100 FOWLS.

	Average number.	Eggs produced per day.	Cost of food consumed.	Profit.
1st period	23¾	25.7	$10.82	$6.31
2d period	23⅔	12.1	14.83	—4.74
3d period	22	38.	13.73	1.95
4th period	21	54.9	10.14	12.62
Entire time	22.6	30.8	49.51	15.35

FLOCK Y.

AMOUNT AND COST OF FOOD CONSUMED.

1st Period. Dec. 14–27 inclusive. Average number 384½.

59.6 lbs.	corn	cost	$ .77
116.1 "	wheat	"	1.68
116.1 "	buckwheat	"	1.39
155.9 "	H. O. feed	"	2 34
4. "	meat scraps	"	.09
22.4 "	fresh ground bone	"	.22
14.9 "	turnips	"	.04
6. "	cabbage	"	.02
Total			$6.55

2d Period. Dec. 28–Jan. 31 inclusive. Average number 374⅕.

265.9 lbs.	corn	cost	$3.46	
163.7 “	wheat	“	2.37	
272.8 “	buckwheat	“	3.27	
99.2 “	corn on ear	“	.79	
331.2 “	H. O. feed	“	4.97	
83.4 “	meat scraps	“	1.79	
101.7 “	fresh ground bone	“	1.02	
19.8 “	cabbage	“	.06	
9.9 “	apples	“	.04	
248.1 “	ground clover and clover midd's	“	1.74	
	Total		$19.51	

3d Period. Feb. 1–28 inclusive. Average number 367¾.

356.9 lbs.	corn	cost	$4.64	
203.3 “	wheat	“	2.95	
292.5 “	buckwheat	“	3.51	
69.4 “	corn on ear	“	.56	
286.5 “	H. O. feed	“	4.30	
29.7 “	meat scraps	“	.64	
125.3 “	fresh ground bone	“	1.25	
66.8 “	cabbage	“	.20	
34. “	apples	“	.14	
	Total		$18.19	

4th Period. Mar. 1–28 inclusive. Average number 363¼.

377. lbs.	corn	cost	$4.90	
326.3 “	wheat	“	4.73	
25.8 “	oats	“	.45	
269.8 “	buckwheat	“	3.24	
347.2 “	mixed feed	“	5.21	
24.8 “	wheat bran	“	.29	
19.8 “	wheat middlings	“	.23	
43. “	meat scraps	“	.92	
71.8 “	fresh ground bone	“	.72	
40.2 “	cabbage	“	.12	
105.4 “	apples	“	.44	
	Total		$21.25	
	Total for entire time			$65.50

NUMBER AND VALUE OF EGGS PRODUCED.

1st Period. Dec. 14–27 inclusive.

Dec. 1– 6,				
“ 7–13,				
“ 14–20,	36 eggs	at .28	per doz.	$ .84
“ 21–27,	36	“ .28	“	.84
Total				$1.68

2d Period. Dec. 28–Jan. 31 inclusive.

Dec. 28–Jan. 3,	42 eggs	at .28	per doz	$ .98
Jan. 4–10,	67	“ .31	“	1.73
“ 11–17,	28	“ .31	“	.72
“ 18–24,	20	“ .25	“	.42
“ 25–31,	51	“ .24	“	1.02
Total				$4.87

3d Period. Feb. 1-28 inclusive.

Feb. 1- 7, 109 eggs	at .24 per doz		$ 2.18
" 8-14, 204	" .16 "		2.72
" 15-21, 265	" .17½ "		3.87
" 22-28, 304	" .16½ "		4.18
Total			$12.95

4th Period. Mar. 1-28 inclusive.

Mar. 1- 7, 304 eggs	at .19 per doz		$ 4.81
" 8-14, 407	" .19½ "		6.61
" 15-21, 751	" .17½ "		10.95
" 22-28, 1092	" .15 "		13.65
Total			$36.02
Total for entire time				$55.52

SUMMARY FOR FLOCK Y.

	Average number of hens.	Number of eggs produced.	Cost of food consumed.	Food cost of one dozen eggs.	Value of eggs.	Excess of value over cost of food. "Profit."
*1st period	384½	72	$ 6.55	$1.09	$ 1.68	$— 4.87
2d period	374⅕	208	19.51	1.12	4.87	—14.64
3d period	367¾	882	18.19	.247	12.95	— 5.24
4th period	363¼	2554	21.25	.10	36.02	14.77
Entire time	372½	3716	65.50	.211	55.52	— 9.98

PER 100 FOWLS.

	Average number.	Eggs produced per day.	Cost of food consumed.	Profit.
*1st period	384½	1.3	$1.70	$—1.26
2d period	374⅕	1.5	5.21	—3.91
3d period	367¾	8.6	4.95	—1.42
4th period	363¼	25.1	5.85	4.06
Entire time	372½	9.5	17.58	—2.68

* Two weeks only.

III. LESSONS FROM THE RECORDS.

Food Cost of One Dozen Eggs.

So far as the food cost of one dozen eggs is concerned, the experiments of 1902–1903 correspond very closely with those of 1901–1902. Naturally there are wide variations in both years. In 1901–2 the minimum cost in any one period was something less than six cents (.054), and the maximum almost $6.00. In 1902–3 the maximum was not exceeded, but the minimum was slightly reduced (.051). The details of all the flocks in both years for all the periods are shown in the table below, the flocks being arranged in order of cheapest production for the entire period :

Year.	Flock.	Breed.	Age.	1st period.	2d period.	3d period.	4th period.	Entire period.
1902–3	M	White Leghorn	pullets	$.187	$.135	$.067	$.051	$.085
1901–2	C	" "	"	.109	.126	.112	.056	.087
1902–3	P–2	" "	"	.345	.109	.080	.053	.093
1902–3	W–2	Mixed	"	.139	.121	.118	.067	.102
1901–2	E	White Leghorn	"	.186	.15	.10	.075	.11
1901–2	F	" "	"	.18	.195	.131	.067	.112
1901–2	K	Mixed	mixed	.186	.127	.122	.076	.113
1901–2	A	White Leghorn	"	.321	.161	.141	.079	.136
1902–3	Q–2	" "	pullets	.133	.23	.153	.075	.135
1902–3	N	" "	"	.216	.153	.168	.095	.142
1901–2	B	" "	hens	.35	.359	.197	.07	.146
1902–3	X–2	Plymouth Rock	pullets	.18	.421	.155	.079	.162
1901–2	J	Mixed	mixed	.517	.305	.216	.054	.163
1902–3	Q–1	White Leghorn	hens	.28	.394	.166	.071	.164
1902–3	Q–2	" "	pullets	.353	.291	.166	.082	.167
1902–3	P–1	" "	hens	1.117	.432	.150	.064	.173
1901–2	L	Mixed	pullets	.348	1.09	.382	.077.	.176
1901–2	H	Black Minorca	pullets	.48	.161	.205	.105	.176
1902–3	O–1	White Leghorn	hens	.301	.363	.201	.087	.181
1902–3	W–1	Mixed	"	.789	.499	.19	.074	.187
1901–2	D	White Leghorn	"	.426	.523	.294	.085	.195
1901–2	G	Brown "	"		1.52	.402	.073	.203
1902–3	R	Brown Leghorn	pullets	.429	.708	.199	.110	.205
1902–3	S	Black Minorca W. Wyandotte	mixed	.443	.568	.211	.147	.233
1902–3	Y	Mixed	mixed	1.09	1.12	.247	.10	.211
1902–3	X–1	Pl. Rock Wyandotte	hens	.391	.672	.271	.154	.30
1902–3	T–1	Black Minorca	"	.861	.96	.364	.125	.32
1902–3	T–2	" "	pullets	1.12	.692	.328	.14	.321
1901–2	I	" "	hens	3.06	2.57	5.82	.098	.339
Average food cost 29 flocks both years								.177
" " " 12 flocks 1901–2								.163
" price 1901–2								.283
" food cost 17 flocks 1902–3								.187
" price 1902–3								.234

From the above table it will be seen that the average cost of production for the whole time, taking each flock as a unit, was about 2 cents per dozen more in 1902–3 than in 1901–2. The average for both years is 17.7 cents. Attention also should be called to the fact that of the 29 flocks participating, 7 produced eggs during the winter at a food cost of less than a cent a piece.

As mentioned in Bulletin No. 204, leading factors in determining the cost of one dozen eggs are the cost of the food and the number of eggs laid. In general the latter was the more important factor. That is, those hens that laid the most eggs produced them at the least cost per dozen regardless of the cost of the ration. This is well shown in the tables below. In order that the cost of food for the different flocks may be readily compared it has been calculated to a basis of 100 fowls :

RELATION OF COST OF FOOD TO COST OF EGGS.

1901–1902.				1902–1903.			
Flock.	Cost of food per 100 hens.	Cost of one dozen eggs.	Rank in cost of egg production	Flock.	Cost of food per 100 hens.	Cost of one dozen eggs.	Rank in cost of egg production.
J	$28.62	$.163	7	Y	$17.58	$ .211	13
G	29.46	.203	11	O–2	30.84	.167	8
F	30.	.112	3	O–1	30.86	.181	10
D	31.02	.195	10	P–2	31.63	.093	2
B	31.26	.146	6	P–1	31.66	.173	9
C	31.28	.087	1	M	32.06	.085	1
E	31.30	.11	2	N	33.91	.142	5
I	31.32	.339	12	W–2	35.61	.102	3
L	31.71	.176	8	W–1	35.64	.187	11
A	36.16	.136	5	Q–2	40.31	.135	4
H	37.92	.176	9	Q–1	40.36	.164	7
K	39.07	.113	4	R	41.88	.205	12
				S	44.78	.233	14
Average .	32.43			X–1	49.38	.30	15
				X–2	49.51	.162	6
				T–1	51.94	.32	16
				T–2	52.20	.321	17
				Average..	38.24		

The flock (J) that was fed at the least cost ranked seventh in cost of egg production while the flock (K) that was fed most expensively ranked fourth in cost of eggs. On the other hand, the two flocks that produced eggs at the east cost (Flock C) and at the greatest cost (Flock I) were fed at a difference lin cost of only four cents per 100 fowls.

It will be seen from the above table that the cost of food per hundred fowls averages considerably more in 1902–3 than it did in 1901–2, the difference amounting to about $6.00, although the food is reckoned at the same prices per pound in each year. This is more apparent than real, for flocks Q, R, X, and T, which include those most expensively fed, all belong to one owner. If these flocks were considered a unit, the average would be very little greater than in 1901–2. As in 1901–2 the flock (Y) that was fed at least cost ranked among the highest (13th) in cost of egg production. Some of the flocks, notably Q–2 and X–2 that were fed at a relatively high cost, ranked very well in cheapness of egg production.

Number of Eggs Produced.

In respect to the number of eggs produced the records of 1902–3 correspond very closely with those of 1901–2. One flock in 1902–3,—and this a good sized one,—made a somewhat better average production for the whole time than any flock in 1901–2, and reached an average production of almost 70 per cent during the month of March. In 1901–2 one of the smaller flocks produced no eggs at all during the first period. In 1902–3 there was no flock that did not produce at least a few eggs all the time. The details of production for all the flocks for each period are shown in the table below, arranged in the order of greatest production, and expressed as "percentage," that is, the number of eggs produced per hundred fowls per day:

PERCENTAGE OF EGGS PRODUCED.

Year.	Flock.	Breed.	Age.	1st period.	2d period.	3d period.	4th period.	Whole time.
1902–3	M	White Leghorn	Pullets	15.9	24.8	45.8	69.1	38.
1901–2	C	" "	"	27.4	23.8	30.	57.8	36.1
1901–2	K	Mixed	Mixed	19.7	32.8	33.	50.9	34.9
1902–3	W–2	"	Pullets	24.3	29.6	33.8	55.5	34.9
1902–3	P–2	White Leghorn .	"	8.1	32.7	42.5	52.8	34.1
1902–3	X–2	Pl. Rock	"	25.7	12.1	38.	54.9	30.8
1902–3	Q–2	White Leghorn .	"	23.	18.9	34.4	47.3	29.9
1901–2	E	" " .	"	17.2	21.	31.4	42.	28.6
1901–2	A	" " .	Mixed	12.9	18.6	28.4	44.	26.8
1901–2	F	" " .	Pullets	15.6	14.5	24.3	48.7	26.8
1902–3	Q–1	" " .	Hens	10.9	11.	31.8	49.9	24.8
1902–3	N	" " .	Pullets	16.1	23.2	22.9	38.5	24.1
1901–2	H	Blk. Minorca ...	"	8.4	21.1	22.	32.7	21.7
1901–2	B	White Leghorn .	Hens	8.5	8.4	17.2	46.5	21.6
1902–3	R	Brown " .	Pullets	7.3	4.6	27.9	51.4	20.6
1902–3	S	Black Minorca } W. Wyandotte }	Mixed	4.2	7.5	26.9	47.5	19.4
1902–3	W–1	Mixed	Hens	4.	7.2	21.	49.7	19.2
1902–3	O–2	White Leghorn	"	8.2	10.6	20.1	38.2	18.6
1902–3	P–1	" "	"	2.6	8.3	22.6	44.	18.5
1901–2	L	Mixed	Mixed	7.3	2.6	9.6	47.2	18.1
1901–2	J	"	"	5.9	11.5	15.	35.5	17.7
1902–3	O–1	White Leghorn .	Hens	9.6	8.5	16.6	36.1	17.2
1902–3	X–1	Pl. Rock } Wyandotte } .	"	11.9	7.6	21.7	28.2	16.6
1902–3	T–2	Blk. Minorca ...	Pullets	4.5	6.5	19.8	37.4	16.4
1902–3	T–1	" " ..	Hens	5.9	4.7	17.9	41.5	16.3
1901–2	D	White Leghorn .	"	7.5	6.5	10.7	36.	16.
1901–2	G	Brown " .	"	0.	1.8	7.7	42.4	14.6
1902–3	Y	Mixed	Mixed	1.3	1.5	8.6	25.1	9.5
1901–2	I	Blk. Minorca ...	Hens	1.1	1.2	.6	30.3	9.3
Average, both years								22.8
" 1901-2								22.7
" 1902–3								22.9

In Bulletin 204 attention was called to the relative production of eggs by hens and pullets, that of the pullets being remarkably larger, particularly during the earlier winter months. During 1902–3 this inquiry has been carried somewhat further, and six of the coöperators kept records of the hens and pullets separately. Of these six, there were two flocks, O and T, that showed no marked difference in the production of the hens and pullets,—as a matter of fact in both cases the pullets laid slightly fewer eggs than the hens,—but the average of all the flocks where the records were kept separately in both years shows a remarkably larger production by the pullets, particularly in the first and second period. This is shown in detail in the following table :

AVERAGE PERCENTAGE OF EGGS.

	1st period.	2d period.	3d period.	4th period.	Whole time.
Pullets......C	27.4	23.8	30.	57.8	36.1
E	17.2	21.	31.4	42.	28.6
O–2	8.2	10.6	20.1	38.2	18.6
P–2	8.1	32.7	42 5	52.8	34.1
Q–2	23.	18.9	34.4	47.3	29.9
T–2	4.5	6.5	19.8	37.4	16.4
W–2	24.3	29.6	33.8	55.5	34.9
X–2	25.7	12.1	38.	54.9	30.8
Average Pullets	17.3	19.4	31.3	48.2	28.7
Hens.......B	8.5	8.4	17.2	46.5	21.6
D	7.5	6.5	10.7	36.	16.
O–1	9.6	8.5	16.6	36.1	17.2
P–1	2.6	8.3	22.6	44.	18.5
Q–1	10.9	11.	31.8	49.9	24.8
T–1	5.9	4.7	17.9	41.5	16.3
W–1	4.	7.2	21.	49.7	19.2
X–1	11.9	7.6	21.7	28.2	16.6
Average Hens....	7.6	7.8	19.9	41.5	18.8

Profit and Loss.

In the discussion herewith, by "profit and loss" is simply meant the relation between the cost of the food consumed and the value of the eggs produced at market rates. No account is made of anything else. The discussion is given to bring out some factors of interest that appear by reason of the varying numbers of eggs laid and the fluctuation in the market price.

The winter of 1901–2 was remarkable both because of the high price of foods and the high price of eggs, the latter running much further toward spring than usual. In fact, the highest quotation for the whole winter, namely 36½ cents, was for the week ending Feb. 21.

In the winter of 1902–3, while the price of foods remained about the same as in 1901–2, the price of eggs from about the first of February on was remarkably lower. This covers the period when the greater number of eggs were laid. consequently the profits are much less in 1902–3 than in 1901–2. For this reason it has seemed best to present the table of profit and loss separately for the two years, the first being reproduced from Bulletin 204 and the second giving the details for 1902–3:

PROFIT (EXCESS OF VALUE OF EGGS OVER COST OF FOOD) PER 100 FOWLS, 1901–2.

Flock.	1st period.	2d period.	3d period.	4th period.	Whole time.
C	$13.02	$10.65	$14.28	$24.22	$62.10
K	5.99	14.50	14.74	18.11	53.10
E	5.09	8.09	15.68	15.20	43.98
F	4.82	4.29	10.74	19.59	38.77
A	—.11	6.59	11.50	16.	33.62
B	—.70	—.92	4.89	17.21	20.32
H	—3.20	7.64	5.24	8.08	17.76
J	—2.78	.10	3.52	15.01	15.09
L	—.60	—4.68	—1.47	15.42	8.14
D	—1.98	—2.79	.77	11.32	6.88
G	—6.83	—5.13	—1.46	15.34	1.80
I	—7.04	—6.46	—7.00	6.35	—14.46

PROFIT (EXCESS OF VALUE OF EGGS OVER COST OF FOOD) PER 100 FOWLS, 1902–3.

Flock.	1st period.	2d period.	3d period.	4th period.	Whole time.
M	$ 3.61	$10.59	$12.00	$20.36	$46.45
W–2	8.79	13.45	5.33	14.31	41.69
P–2	—1.20	15.92	10.30	15.37	40.58
Q–2	8.15	2.94	2.37	11.28	24.68
N	1.88	8.78	.66	7 25	18.54
X–2	6.31	—4.74	1.95	12.62	15.35
Q–1	.16	—3.89	1.13	12.33	9.51
O–2	—1.31	—.44	.80	7.42	6.29
O–1	—.32	—2.18	—.60	6.84	3.74
P–1	—5.01	—3.81	1.52	11.47	3.73
W–1	—4.70	—4.69	—.48	11.75	1.17
R	—2.47	—5.82	—1.00	7.94	—2.33
Y	—1.26	—3.91	—1.42	4.06	—2.68
S	—1.55	—6.36	—1.93	2.97	—7.44
X–1	—2.87	—8.73	—4.63	1.63	—14.65
T–1	—7.86	—9.33	—8.00	4.85	—20.60
T–2	—8.80	—9.67	—7.00	3.07	—22.40

General Summary.

As a general summary the flocks have been arranged below in order of cost of eggs per dozen, giving also the rank in percentage of eggs laid, and cost of food consumed:

Flock.	Breed.	Age.	Food cost of one dozen eggs.		Eggs laid per 100 fowls per day.		Cost of food consumed per 100 fowls.	
			Amt.	Rank.	Number.	Rank.	Amt.	Rank.
M	White Leghorn ...	pullets	$.085	1	38.	1	$32.06	15
C	"	"	.087	2	36.1	2	31.28	9
P-2	"	"	.093	3	34.1	5	31.63	12
W-2	Mixed	"	.102	4	34.9	4	35.61	17
E	White Leghorn ...	"	.11	5	28.6	8	31.30	10
F	"	"	.112	6	26.8	10	30.	4
K	Mixed	mixed	.113	7	34.9	3	39.07	21
A	White Leghorn ..	"	.136	8	26.8	9	36.16	19
Q-2	"	pullets	.135	9	29.9	7	40.31	22
N	"	"	.142	10	24.1	12	33.91	16
B	"	hens	.146	11	21.6	14	31.26	8
X-2	Plymouth Rock .	pullets	.162	12	30.8	6	49.51	27
J	Mixed	mixed	.163	13	17.7	21	28.62	2
Q-1	White Leghorn ...	hens	.164	14	24.8	11	40.36	23
O-2	"	pullets	.167	15	18.6	18	30.84	5
P-1	"	hens	.173	16	18.5	19	31.66	13
L	Mixed	pullets	.176	17	18.1	20	31.71	14
H	Black Minorca	"	.176	18	21.7	13	37.92	20
O-1	White Leghorn .	hens	.181	19	17.2	22	30.86	6
W-1	Mixed	"	.187	20	19.2	17	35.64	18
D	White Leghorn ..	"	.195	21	16.	26	31.02	7
G	Brown Leghorn ..	"	.203	22	14.6	27	29.46	3
R	"	pullets	.205	23	20.6	15	41.88	24
S	Black Minorca W. Wyandotte . ..	mixed	.233	24	19.4	16	44.78	25
Y	Mixed	"	.211	25	9.5	28	17.58	1
X-1	Pl.Rock Wyandotte	hens	.30	26	16.6	23	49.38	26
T-1	Black Minorca ..	"	.32	27	16.3	25	51.94	28
T-2	"	pullets	.321	28	16.4	24	52.20	29
I	"	hens	.339	29	9.3	29	31.32	11

IV. CONCLUSIONS.

In the seventeen weeks from Dec. 1, 1901 to Mar. 29, 1902, and in the similar period of 1902-3, in 29 flocks representing ten owners and 5200 fowls, the average daily production of eggs was 22.8 per 100 fowls.

During the same period the average food cost of one dozen eggs was nearly eighteen (.177) cents. The flocks that laid most eggs during December and January laid most eggs also in March.

The egg production of pullets was notably in excess of that of hens particularly in the earlier periods when the price of eggs was highest.

The average cost of feeding 100 hens for 17 weeks was $35.33.

The average value of product exceeded the cost of food by $16.13 per 100 fowls.

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CORNELL UNIVERSITY
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THE COLLEGE OF AGRICULTURE
Department of Animal Husbandry

METHODS OF MILKING.

By HENRY H. WING and JAMES A. FOORD.

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METHODS OF MILKING.

Milking the dairy cow is such a simple operation, and one that occupies in the aggregate, so much of the dairyman's time, that it is easy to become careless about it and to look upon the operation as one not requiring skill nor demanding scientific investigation. The feeding of the herd has received careful attention, both by investigators and farmers, until it is now probably correct to say that the dairy cow in the hands of the progressive dairyman is more scientifically fed and nourished than most children. The ventilation and sanitation of stables has also been the subject of much discussion, but it is certainly a fact that the art of milking has not received the attention it deserves, at least not until very recently.

I. COMPARISON OF REGULAR MILKING AND RESIDUAL MILKING.

The experiments recorded in this bulletin are published at this time in order to call the attention of our farmers and dairymen to what seems to be a frequent source of financial loss in the care and management of dairy herds, —not securing all the milk that is secreted by the cow. The experiments were begun to determine the value of the so-called Hegelund method of milking. This method was originated and first recommended in 1900 by a Danish Dairy School teacher, Dr. J. Hegelund, but its introduction into the United States is due to Professor F. W. Woll of the Wisconsin Agricultural Experiment Station, to whom we are indebted for valuable suggestions as well as for the loan of cuts for Figs. 1–5, (See p. 65).

The Hegelund method of milking is in reality a series of manipulations of the udder made by the milker as soon as the full flow of milk has ceased, in order to secure all the milk secreted by the cow. The same end used to be secured by stripping, but the assertion is made that stripping does not completely remove all the milk, while the Hegelund method does. The comparison made between the two methods at this Station, however, as well as those at the Wisconsin Experiment Station (See Wisconsin Bulletin 96) seem to show results only slightly in favor of the Hegelund method over stripping. The results are given in detail later on. A description of the Hegelund method is given on p. 64.

The first experiment at Cornell was begun in May, 1903, with the University herd. Twelve cows were used, this number being divided into three groups of four each ; the groups were so chosen as to be as nearly uniform as possible, as to breed, age and week of lactation.

NOTE.—Mr. James A. Foord was assistant in animal husbandry and dairying in Cornell University when these experiments were made. He is now Professor of Agriculture in Delaware College.

The cows were milked as usual by the regular milkers, and the milk weighed and a composite sample taken for testing. As soon as a milker had finished with a cow, the animal was after-milked by the Hegelund method by one or other of the writers, the after-milk weighed and an aliquot composite sample taken for testing. The testing was done at the end of each week.

The milkers were asked to milk the cows in the usual way—that is, not to take any more time or care in securing all the milk than was their custom. With reference to the milkers of the University herd, we think this request was carried out, because the men were accustomed to having the Station workers make experiments from time to time and therefore were not at all suspicious that their ability as milkers would be questioned. A cow that yielded considerable residual milk when milked by any one milker, generally gave approximately the same amount of residual milk if milked by another man, in the absence of the regular milker.

The breeds and ages of the cows, together with other data relating to the experiments, are as follows :

I. THE COWS.

Group.	Name.	Age.	Months in milk.	Month of gestation.	Breed.	Milker.
A	Alpha	4	11	——	Holstein	III
	Beta........	4	6	4	Holstein	III
	Lily	3	1½	——	Jersey	I
	Rose........	4	5½	4	Grade Guernsey	I
B	Belle.	8	6½	4½	Jersey-Holstein	II
	Fidget	3	½	——	Grade Jersey	II
	DeKol	6	4	1	Holstein	III
	Vina...	5	6	3	Grade Holstein	I
C	Gamma......	3	9	5½	Holstein	III
	Julia	11	5	3½	Grade Holstein	II
	Tabby	6	8½	5½	Jersey	II
	V. Exile	5	4	——	Jersey	I

The following tables show the amount of milk, the percentage of fat, and the actual amount of fat secured at both the regular and residual milkings. The amounts show the production per week for each cow and also the total for the group. As shown by the tables, the Hegelund method was applied to Group A on alternate weeks, while with Group B the work was continued for two weeks. In both cases the production for the week preceding the beginning of the experiment is given :

II.—RECORD OF GROUP A.

	Cow.	Regular milking.			Residual milking.		
		Pounds of milk.	Per cent of fat.	Pounds of fat.	Pounds of milk.	Per cent of fat.	Pounds of fat.
First week, May 13–20.	Alpha	208.5	3.4	7.089			
	Beta	203.9	3.2	6.525			
	Lily	167.4	4.8	8.035			
	Rose	179.8	4.5	8.091			
	Total	759.6		29.740			
Second week, May 20–27.	Alpha	214.4	3.2	6.861	10.00	7.6	.760
	Beta	200.5	3.3	6.617	7.90	6.3	.498
	Lily	166.5	4.6	7.659	3.75	11.3	.424
	Rose	174.5	4.4	7.678	7.45	9.9	.738
	Total	755.9		28.815	29.10		2.420
Whole herd turned to pasture beginning with part of day May 25.							
Third week, May 27–June 3.	Alpha	244.5	3.3	8.069			
	Beta	223.2	3.6	8.035			
	Lily	190.5	5.0	9.525			
	Rose	206.8	4.7	9.720			
	Total	865.0		35.349			
Fourth week, June 3–10.	Alpha	245.4	3.2	7.853	8.30	6.0	.498
	Beta	228.6	3.2	7.315	5.90	6.8	.401
	Lily	194.6	5.2	10.119	4.00	11.9	.476
	Rose	214.5	4.2	9.009	7.30	10.1	.737
	Total	883.1		34.296	25.50		2.112
Fifth week, June 10–17.	Alpha	244.3	3.2	7.818			
	Beta	225.2	3.4	7.657			
	Lily	194.5	5.0	9.725			
	Rose	216.6	4.5	9 747			
	Total	880.6		34.947			

III.—RECORD OF GROUP B.

	Cow.	Regular milking.			Residual milking.		
		Pounds of milk.	Per cent of fat.	Pounds of fat.	Pounds of milk.	Per cent of fat.	Pounds of fat.
First week, May 13–20.	Belle	116.7	4.4	5.135			
	Fidget	113.4	5.0	5.670			
	DeKol	245.2	3.2	7.846			
	Vina	223.4	3.0	6.702			
	Total	698.7		25.353			
Second week, May 20–27.	Belle	114.	4.2	4.788	11.35	6.4	.726
	Fidget	107.4	5.0	5.370	4.20	10.9	.458
	DeKol	236.8	3.3	7.814	13.60	5.2	.707
	Vina	217.9	2.9	6.319	8.55	5.8	.496
	Total	676.1		24.291	37.70		2.387
Whole herd turned to pasture beginning with part of day May 25.							
Third week, May 27–June 3.	Belle	120.6	4.3	5.186	12.10	7.1	.859
	Fidget	120.1	5.2	6.245	3.95	11.3	.446
	DeKol	278.2	3.4	9.459	9.35	6.3	.589
	Vina	239.1	3.2	7.651	9.50	5.8	.551
	Total	758.0		28.541	34.90		2.445
Fourth week, June 3–10.	Belle	126.1	4.0	5.044			
	Fidget	121.2	4.8	5.818			
	DeKol	296.1	3.2	9.475			
	Vina	252.3	3.1	7.821			
	Total	795.7		28.158			
Fifth week, June 10 17.	Belle	122.9	4.2	5.162			
	Fidget	129.0	5.8	7.482			
	DeKol	288.0	3.1	8.928			
	Vina	240.3	3.2	7.690			
	Total	780.2		29.262			

The cows were first turned to pasture May 25, thus making an unfortunate difference in the feed between the time preceding and that following that date. The first two weeks, however, can be compared very well, and for the last three weeks the cows were also under practically the same treatment.

It will be noted that, considering only the regular milkings, the total weekly production of milk by Group A was practically the same in the first and second weeks, while during the fourth week the amount of milk produced was greater than that secured either in the third or fifth week. The variation in the amount of fat was a little greater, but not more than frequently occurs under uniform conditions. *Considering Group A, the figures seem to justify the conclusion that the residual milk procured by the Hegelund method, in the second and fourth weeks, was not detrimental to the production at the regular milkings; in other words it would appear that the milk secured by after-milking was all gain.*

If the total weekly production from the regular milkings of Group B, is studied carefully and in connection with Group A, a similar conclusion may be made, although it is perhaps not so evident at the first glance.

The average amount of milk and fat produced per cow per week at both the regular and residual milkings is shown in the following table. Group C was used in comparing the Hegelund method with stripping; the results of this comparison are given later on, but are included in this table, as well as Groups A and B, which have already been discussed:

IV.—Average Production per Week Groups A, B, and C.

Group.	Date.	Regular milking.		Residual milking.	
		Pounds of milk.	Pounds of fat.	Pounds of milk.	Pounds of fat.
A 4 cows	May 13–20	189.9	7.435		
	" 20–27	189.0	7.204	7.28	.605
	May 27–June 3	216.3	8.837		
	June 3–10	220.8	8.574	6.38	.528
	" 10–17	220.2	8.737		
B 4 cows	May 13–20	174.7	6.338		
	" 20–27	169.0	6.073	9.43	.597
	May 27–June 3	189.5	7.135	8.73	.611
	June 3–10	198.9	7.040		
	" 10–17	195.1	7.316		
C 4 cows	May 20–27	159.9	5.773		
	May 27–June 3	162.8	5.904	*10.36	.694
	June 3–10	163.2	5.721	10.30	.712
	" 10–17	167.2	5.951		
		2616.5	98.038	52.48	3.747
All	Whole time	186.9	7.003	**8.75**	**.625**

* Secured by stripping.

A study of the three preceding tables (II, III, IV), together with the record of Group C, page 62, shows that the amount of milk secured per cow per week from animals in the University herd, either by after-milking or stripping, varied from 3.75 pounds (Lily, Group A) to 13.60 pounds (DeKol, Group B); and that the amount of fat contained in the residual milk varied from .401 pounds (Beta, Group A) to 1.011 pounds (V. Exile, Group C). The average amount of residual milk per cow per week was 8.75 pounds, containing .625 pounds of fat.

Owing to the uniformity of the results throughout the experiment, it was thought that further work along this line would be of more value if conducted in other herds. Arrangements were made early in July with Mr. Geo. B. Tallman of Perry, N. Y., to allow the junior writer to test the value of the Hegelund method in his herd. The herd consists chiefly of thoroughbred Guernseys, but includes a few high grades.

V. ANIMALS IN THE SECOND EXPERIMENT.

Name.	Age.	Breed.	Month of lactation.	Milker.
Acorn	8	Guernsey	10	B
Belle	12	"	3	A
Bob	4	Grade Guernsey	5	A
Brindle	5	Jersey-Guernsey	2	A
Cherry	5	Grade Guernsey	5	C
Galway	8	Guernsey	8	B
*Elite	7	"	14	C
Maiden	2	"	2	B
Valley Girl	6	"	4	C
Wright	4	Grade Guernsey	5	A

* Result not tabulated; shrinking rapidly in milk production due to advanced gestation.

The milk of each animal was weighed by the owner and a composite sample taken for testing for a week preceding the time when after-milking was begun. After-milking was employed for one week. All testing and after-milking was done by the junior writer. Aliquot composite samples were taken, the milk was tested by the Babcock centrifugal method, and duplicate tests were made in all cases. A summary of the results follows :

VI. RESULTS IN THE SECOND EXPERIMENT.

	Cow.	Milker.	Regular milking.			Residual milking.		
			Pounds of milk.	Per cent of fat.	Pounds of fat.	Pounds of milk.	Per cent of fat.	Pounds of fat
First week, July 4–11.	Acorn	B	160.8	5.1	8.20			
	Belle......	A	209.5	4.6	9.64			
	Bob	A	158.1	5.1	8.06			
	Brindle......	A	202.2	4.2	8.49			
	Cherry	C	245.4	4.0	9.82			
	Galway .. .	B	174.3	4.8	8.37			
	Maiden	B	192.0	4.3	8.26			
	Valley Girl ..	C	203.6	4.8	9.77			
	Wright	A	177.7	4.2	7.46			
	Total......	....	1723.6		78.07			
	Average ...	....	191.5		8.67			
Second week, July 11–18.	Acorn	B	159.1	5.1	8.11	2.45	9.4	.230
	Belle	A	209.2	4.4	9.20	5.30	11.7	.620
	Bob	A	156.3	4.9	7.66	3.90	15.0	.585
	Brindle .. .	A	203.1	4.0	8.12	4.60	11.4	.524
	Cherry	C	237.7	3.8	9.03	8.05	11.2	.902
	Galway	B	168.5	4.0	6.74	10.55	11.5	1.213
	Maiden ...	B	182.1	4.0	7.28	3.45	8.2	.283
	Valley Girl ..	C	207.1	4.6	9.53	2.90	12.4	.360
	Wright	A	173.3	4.3	7.45	3.00	9.6	.288
	Total	....	1696.4		73.12	44.20		5.005
	Average . .	....	188.5		8.12	4.91		.556

The cows all received similar treatment throughout the experiment, but, unfortunately, the weather conditions varied greatly. During the first week, July 4–11, the weather was warm and dry and conditions were favorable for milk production. The second week as a whole was exceptionally cold and rainy, and not at all favorable for a maximum yield. This accounts for less milk being secured at the regular milkings in the second week. If the milk secured by after-milking is added, however, the production in the second, or rainy week, compares favorably with that secured in the first, the amount of fat being practically the same, and the amount of milk slightly in excess. *The amount of residual milk secured per cow per week in this herd varied from 2.45 pounds containing .23 pounds of fat (Acorn), to 10.55 pounds of milk containing 1.213 pounds of fat (Galway). The average production for the week was 4.91 pounds of milk and .556 pounds of fat.* The average amount of residual milk is less than that from the University herd. The average percentage of fat in the milk is slightly higher, due probably to the breed. It is an interesting fact that the two cows, Cherry and Galway, that gave the largest amounts of residual milk and fat, were milked by the two most careful milkers.

The milkers in this herd did their work better than the average milker, due probably in large part to the fact that the owner himself was with the herd every day and had the details of its care and management under careful supervision. On the other hand, the writer felt that one or two of the men were taking special pains to milk thoroughly the cows that were under experiment. To determine this, the residual milk from several additional cows was taken during the week, the men not knowing until they had finished milking that the animals were to be after-milked. The results follow:

VII.—RESIDUAL MILK FROM COWS NOT UNDER REGULAR EXPERIMENT.

Date.	Cow.	Milker.	Residual milking.			Regular milking, Pounds of milk per day, approximate.
			Pounds of milk.	Per cent of fat.	Pounds of fat.	
July 11, P. M.	Cosette	A	1.00	9.3	.093	20
" 13, A. M.	"	D	.4	12.7	.051	20
" 12, A. M.	Buttercup	C	.5	12.2	.061	30
" P. M.	"	C	.2	13.0	.026	30
" 17, A. M.	Tully	D	.3	11.2	.034	17
"	Buckskin	A	.7	14.3	.100	19
"	Moselia	A	.45	13.3	.060	30
"	Alma	E	.75	7.6	.057	23
"	Fern	A	1.00	9.8	.098	18
"	Lily's Choice	C	.1	8.8	.009	20
Average		A and E	.78		.081	
Average		D and C	.30		.036	

Based on the averages in Table VII, if butter fat were worth twenty-five cents per pound and each man were milking ten cows, milkers A and E were each losing twenty cents' worth of fat per milking, while milkers D and C were leaving in the udders only nine cents' worth per milking.

By referring to the regular experiment,—that is, those cows that the milkers knew were to be after-milked (Table VI),—it will be noticed that all the cows milked by A gave very small amounts of after-milk, while in the above record (Table VII) of cows that the milkers did not know were to be after-milked, the cows handled by A gave an average of slightly over three quarters of a pound of milk per milking. It would seem just to say that milker A was more careful to milk thoroughly those cows that he knew were to be after-milked. This may be one reason why the average amount of after-milk secured by the Hegelund method in this herd was less than the average amount in the University herd.

The third experiment to test the value of the Hegelund method was made in the herd of a farmer living near the University. It continued only twenty-four hours. The results are given in the following table, each milking being stated separately:

VIII.—THE THIRD EXPERIMENT.

	Cow.	Regular milking.			Residual milking.			Milker.
		Pounds of milk.	Per cent of fat.	Pounds of fat.	Pounds of milk.	Per cent. of fat.	Pounds of fat.	
P. M. milking July 31.	Brindle ...	14.9	4.2	.626	1.00	14.6	.146	Y
	Emerson ..	16.2	4.1	.664	1.20	6.8	.082	Z
	Lop Horn .	13.1	3.8	.498	1.05	9.4	.100	Y
	Mason	7.0	5.6	.392	.50	11.0	.055	Z
	Muley	9.2	5.1	.469	.35	12.4	.043	W
	Pansy	9.6	4.2	.403	.50	13.0	.065	Y
	Rose	13.4	4.4	.590	.45	12.0	.054	X
	Spike Horn	6.8	1.7	.116	1.75	4.5	.079	V
	Triplet	14.1	2.5	.353	2.25	12.2	.275	Y
	Total	104.3		4.111	9.05		.899	
A. M. milking Aug. 1.	Brindle . ..	13.0	3.5	.455	.40	10.9	.044	X
	Emerson ..	15.3	4.0	.612	1.00	5.7	.057	Z
	Lop Horn ...	11.0	3.4	.374	1.55	6.6	.102	Y
	Mason	5.7	4.5	.257	.10	7.0	.007	Z
	Muley	9.5	4.8	.456	.20	7.6	.015	Z
	Pansy.......	8.0	3.6	.288	.70	8.9	.062	Y
	Rose	10.7	2.7	.289	.40	7.8	.031	X
	Spike Horn..	7.0	2.3	.161	3.90	7.8	.304	Y
	Triplet .. .	13.7	4.0	.548	.20	10.9	.022	Z
	Total	93.9		3.440	8.45		.644	
	Total 24 hrs.	198.2		7.551	17.50		1.543	
	Av'g. 24 hrs.	22.0		.839	**1.94**		**.171**	

These cows were under the observation of the Experiment Station officers for other purposes, and the milk of each animal was weighed by the owner at each milking. A study of the week's record fails to show any great variation in the amount of milk secured at the regular milkings on the day on which after-milking was practiced. The production of milk at the regular milkings during the week was as follows:

IX.—REGULAR MILK PRODUCTION IN THE THIRD EXPERIMENT.

For 24 hour period.

Tuesday	Wednesday		Thursday		Friday		Saturday		Sunday		Monday		Tuesday
P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.
213.6		216 5		198.0		*198.2		208.8		201.7		204.8	

* After-milking practiced.

The milkers X, Y and Z (Table VIII) were the regular ones, while V and W were extra harvest hands who milked only at evening; X was the owner of the herd, and Y a young woman.

The above table (VIII) shows that seventeen and one-half pounds of milk containing a trifle over one and one-half pounds of actual butter fat were secured by *after-milking nine cows at the two regular milkings during twenty-four hours. At 25 cents per pound for butter fat, the actual cash gain by after-milking from the nine cows was thirty-eight and one-half cents in twenty-four hours.*

Considering the total amount of milk and fat secreted by these nine cows, a little over eight per cent (8.11%) of the milk and nearly seventeen per cent (16.96%) of the fat were left in the udder by careless milking.

II. COMPARISON OF THE HEGELUND METHOD WITH STRIPPING.

Group C of the University herd was used to compare the Hegelund method of after-milking with stripping or clean milking. During the week May 27–June 3, the cows of this group were stripped for three minutes as soon as the regular milker had finished; the milk thus secured was weighed and sampled the same as the other after-milk. The following week, June 3–10, the cows of Group C were after-milked by the Hegelund method.

The following table shows the amounts of milk and fat produced at both the regular and residual milkings, together with the production for the week preceding and the week following those when stripping or after-milking was practiced:

X.—STRIPPING VERSUS THE HEGELUND METHOD.

	Cow.	Regular milking.			Residual milking.		
		Pounds of milk.	Per cent of fat.	Pounds of fat.	Pounds of milk.	Per cent of fat.	Pounds of fat.
May 20–27.	Gamma	175.7	3.6	6.325			
	Julia	234.0	2.8	6.552			
	Tabby	83.1	4.7	3.906			
	V. Exile	146.7	4.3	6.308			
	Total	639.5		23.091			
May 27–June 3.					Obtained by stripping.		
	Gamma	172.8	3.8	6.048	8.10	6.1	.429
	Julia	255.0	3.0	7.650	13.35	5.0	.668
	Tabby	82.5	4.5	3.713	8.25	8.0	.668
	V. Exile	141.0	4.4	6.204	11.75	8.6	1.011
	Total	651.3		23.615	41.45		2.776
June 3–10.					Obtained by Hegelund method.		
	Gamma	166.9	3.5	5.842	8.15	5.3	.432
	Julia	256.7	3.0	7.701	10.60	6.1	.647
	Tabby	87.6	4.2	3.679	10.15	8.1	.822
	V. Exile	141.5	4.0	5.660	12.30	7.7	.947
	Total	652.7		22.882	41.20		2.848
June 10–17.	Gamma	157.0	3.6	5.652			
	Julia	262.8	2.8	7.358			
	Tabby	89.0	4.4	3.916			
	V. Exile	159.9	4.3	6.876			
	Total	668.7		23.802			

The foregoing table shows plainly that the amount procured by stripping was practically the same as that procured when the Hegelund method was practiced.

During the week of May 27–June 3, an amount of milk equal to 6.36 per cent of that secured at the regular milking was secured by stripping, and the amount of fat it contained was equal to 11.7 per cent of the total fat in the regular milkings.

During the following week, June 3–10, the amount of milk secured by after-milking, according to our understanding of the Hegelund method, was 6.31 per cent of that secured at the regular milkings ; the fat it contained was equal in amount to 12.4 per cent of the total amount of fat from the regular milkings.

The results of our work with Group C seem to be conclusive, but the number of cows was small and the experiment was not continued very long ; hence we have taken the liberty of tabulating the results of similar work at the Wisconsin Experiment Station. The figures from which this data is secured are taken from Bulletin 96 of that Station :

XI.—RESULTS AT THE WISCONSIN STATION LOT III. EIGHT COWS.

Week.	Residual milk obtained by	Regular milking.		Residual milking.			
		Pounds of milk.	Pounds of fat.	Milk.		Fat.	
				Pounds.	Per cent of amount at regular milking.	Pounds.	Per cent of amount at regular milking.
1		1424.1	60.16				
2	Hegelund method..	1396.9	58.10	61.45	4.39	5.25	9.03
3	Stripping	1298.0	54.77	50.85	3.91	4.03	7.35
4		1199.3	51.64				
5	Hegelund method..	1220.3	52.29	48 65	3.98	4.08	7.80

The variation is slightly in favor of the Hegelund method, but the difference is so small that a definite statement in favor of either method can hardly be made. *After reviewing all the work at both the Cornell and Wisconsin Stations, it seems safe to say that the advantage of the Hegelund method over stripping, under our conditions, still remains to be proved.*

It is the opinion of the writers that the stripping as well as the milking, except in unusual cases, should be done with the whole hand and not with the thumb and forefinger alone. In milking, the thumb should be turned out and never enclosed within the palm, as is often done. The hand should be opened wide enough to allow the teat to fill to its full capacity, aided by a slight upward pressure upon the udder ; the thumb and forefinger should then be closed, folowed by the second, third and fourth fingers in the order named.

III.—SUMMARY AND ADVICE.

In the herds experimented with there was secured either by the Hegelund method of after-milking or by stripping the following amounts of milk and fat, in addition to the regular amounts :

Herd.	Per cow per day.					
	Highest.		Lowest.		Average.	
	Pounds of milk.	Pounds of fat.	Pounds of milk.	Pounds of fat.	Pounds of milk.	Pounds of fat.
University.....					1.25	.089
Tallman ..	2.20	———	.10	———	.70	.079
No.—3........	5.65	.383	.55	.058	1.94	.171

Experiments seem to indicate that these amounts were gained, and if left in the udder would have been lost to the dairyman.

There is a large financial loss in many dairies due to careless milking.

The milk left in the udder by a careless milker is practically lost.

All the milk secreted by a cow should be drawn at each milking. If necessary, manipulation of the udder and stripping should be resorted to in order to accomplish this end.

The after-milking should be done by the regular milker and need take but little extra time.

It is probable that such clean milking is an incentive to secretion and will increase the total yearly production of the animal.

IV. DESCRIPTION OF THE HEGELUND MANIPULATION.

The manipulations used in the Hegelund method of milking are described on pages 8 and 9 of Bulletin No. 96 of the Wisconsin Experiment Station, and are copied here. They have also appeared in various agricultural and dairy periodicals. They are given here because many who receive this bulletin may not have seen them. For the use of the cuts we are indebted to Professor Woll and the Wisconsin Experiment Station.

First Manipulation.—The right quarters of the udder are pressed against each other (if the udder is very large, only one quarter at a time is taken) with the left hand on the hind quarter and the right hand in front on the fore quarter, the thumbs being placed on the outside of the udder and the four fingers in the division between the two halves of the udder. The hands are now pressed toward each other and at the same time lifted toward the body of the cow. This pressing and lifting is repeated three times, the milk collected in the milk cistern is then milked out, and the manipulation repeated until no more milk is obtained in this way, when the left quarters are treated in the same manner. (Figs. 1 and 2.)

Second Manipulation.—The glands are pressed together from the side. The fore quarters are milked each by itself by placing one hand, with fingers spread, on the outside of the quarter and the other hand in the division between the right and left fore quarters; the hands are pressed against each other and the teat then milked. When no more milk is obtained by this manipulation, the hind quarters are milked by placing a hand on the outside of each quarter, likewise with fingers spread and turned upward, but with the thumb just in front of the hind quarter. The hands are lifted and grasp into the gland from behind and from the side, after which they are lowered to draw the milk. The manipulation is repeated until no more milk is obtained. (Figs. 3 and 4.)

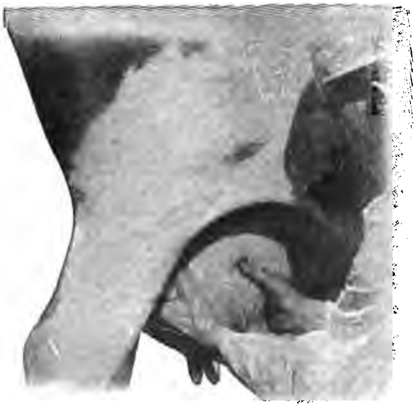


Fig. 1.

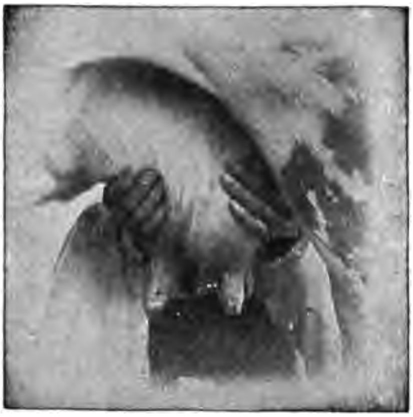


Fig. 2.

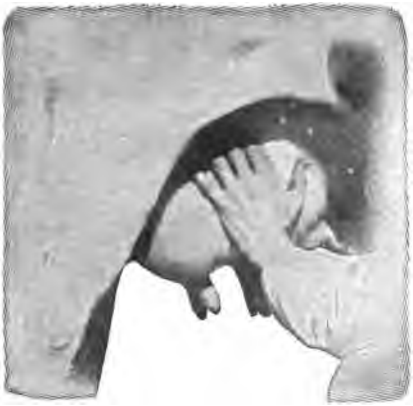


Fig. 3.

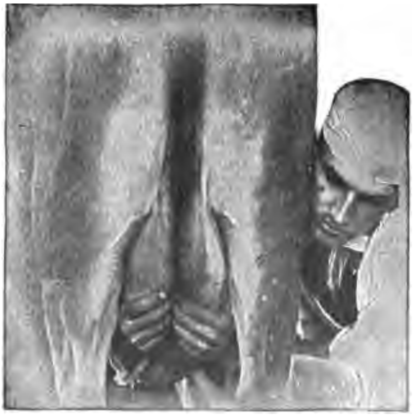


Fig. 4.

Third Manipulation.—The fore teats are grasped with partly closed hands and lifted with a push toward the body of the cow, both at the same time, by which method the glands are pressed between the hands and the body; the milk is drawn after each three pushes. When the fore teats are emptied, the hind teats are milked in the same manner. (Fig. 5.)

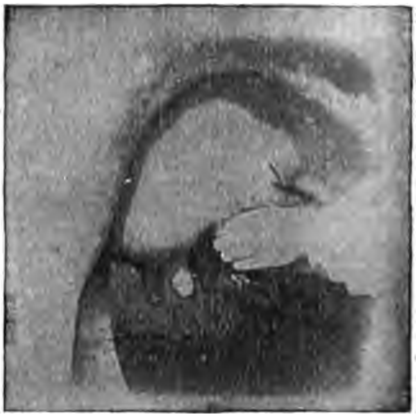
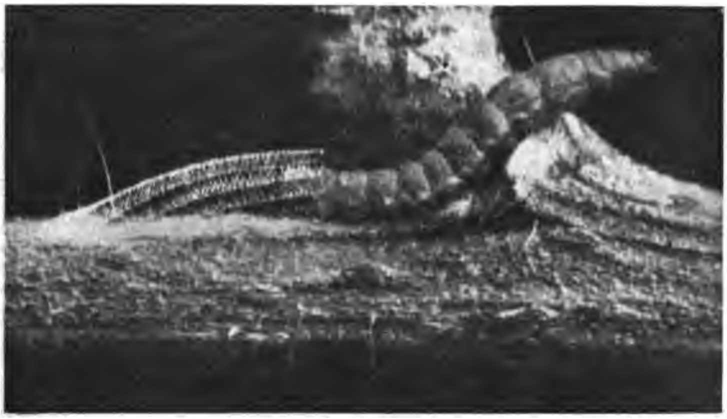


Fig. 5.

DECEMBER, 1903 BULLETIN 214

CORNELL UNIVERSITY
EXPERIMENT STATION OF
THE COLLEGE OF AGRICULTURE
Department of Entomology

THE RIBBED COCOON-MAKER OF THE APPLE



By M. V. SLINGERLAND
and
PHILENA B. FLETCHER

ITHACA, N. Y.
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The regular bulletins of the Station are sent free to persons residing in New York State who request them.

EXPERIMENT STATION, COLLEGE OF AGRICULTURE,
CORNELL UNIVERSITY, ITHACA, N. Y., April 30, 1904.

HON. C. A. WIETING,
COMMISSIONER OF AGRICULTURE, ALBANY.

Sir:—I submit herewith a report on a very serious blight of onions. This disease has been prevalent in New York State for some years, and it seems to be spreading. The disease attacks the foliage of the onion, thereby injuring the plant to such an extent that the bulb does not reach full size, or even killing the plant. The treatment to be employed is largely preventive,—to practice rotation and to destroy all affected foliage as soon as the crop is harvested. Since onion lands are usually limited in quantity in any locality, however, it is not always possible to practice systematic rotation. Much can be accomplished by means of thorough spraying with Bordeaux mixture, but the grower must be alert and begin the work before the disease gains much headway. It is probable that the disease is not carried in the seed itself, but it may be conveyed in the dust that adheres to the seed or in the litter that accompanies it. Suspected seed may be treated with formalin.

New York leads the states in the production of onions. The Twelfth Census places the New York crop, "grown by farmers in commercial quantities," at 2,177,271 bushels. "New York led in the production of onions as in that of potatoes, producing as many bushels of onions as any other three states except Ohio, which raised over two-thirds the quantity reported for New York."

We desire to secure complete information as to the extent of the onion blight in New York State, and also to conduct further experiments aiming to control it. To these ends, we ask for correspondence from the onion growers. The present report is considered to be preliminary, designed primarily to interest onion growers and gardeners in the checking of this disease. The more technical part of the studies is a contribution to the life-history and morphology of the fungus that causes the blight. All the work has been done under the supervision of Professor G. F. Atkinson.

The following outline will enable the reader to find the particular parts of the bulletin in which he may be interested :

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  How the disease effects the onion - - - - - - - - - " 143
  Treatment - - - - - - - - - - - - " 146
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  The fungus.—Its name and life history - - - - - " 149
  Conditions affecting the life of the parasite - - - - - - " 153
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  History of the disease - - - - - - - - - - " 158
  Common name of the disease - - - - - - - - - " 159
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Respectfully submitted,
L. H. BAILEY,
Director.

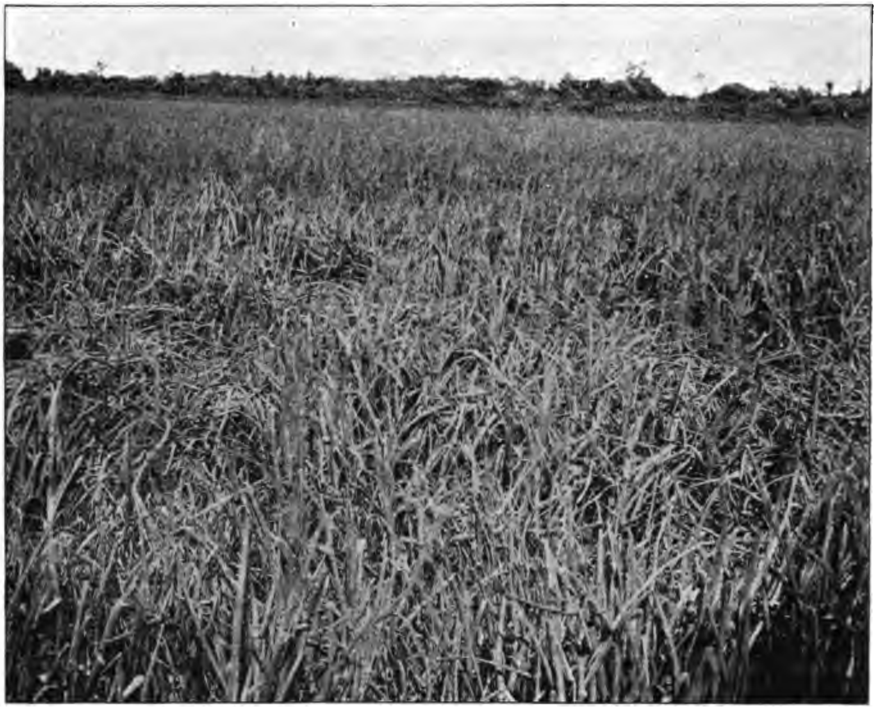

FIG. 1.—*Onion field of Bonney and Ware, Batavia, N. Y., showing a bad spot of blight along the front side. Tops down, dead and rotting.*

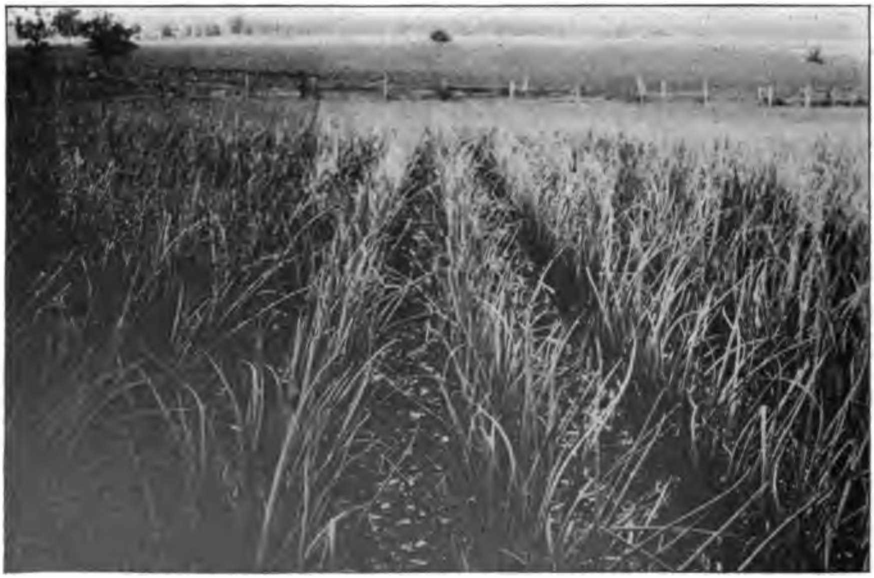

FIG. 2.—*Onion field of W. A. Culver, Mecklenburg. Front side, showing onions recovered after first attack. Erect tops are the new growth. The new blighted tops are dried up and may be seen along the sides of the rows near the ground. Taken July 21, 1903.*

A SERIOUS OUTBREAK OF ONION BLIGHT IN 1903.

PART I. POPULAR ACCOUNT OF THE DISEASE, WITH REMEDIES.

On July 13, 1903, Mr. W. A. Culver from near Mecklenburg, N. Y., brought to the botanical laboratory a large bunch of onions, the tops of which were badly affected with some disease. This was at once recognized as the Onion Blight or Mildew (caused by a parasitic fungus, *Peronospora Schleideniana*). Mr. Culver said that the disease was very severe, his entire field of five acres having been attacked in the course of a very few days. From the appearance at that time he had little hope of any crop at all. He was advised to spray the onions thoroughly at once with Bordeaux mixture. We made a visit to the farm of Mr. Culver to observe the disease in the field and to obtain more material for study in the laboratory.

On July 27th a letter was received from Bonney & Ware of Batavia, N. Y., saying that some disease was causing trouble in their onions. I visited their farm the next day. As anticipated, the trouble here was also found to be due to the blight, though it was not so severe as at Mr. Culver's.

It was observed in both these cases that the disease originated in one or two definite spots in the onion field. It was first recognized by the bleached appearance of the leaves, followed by their sudden collapse. The area where the disease first occurred was usually small but very striking in appearance, (Fig. 1.) The tops looked as if they had been dashed with scalding water. A close examination of the leaves in the earlier stages of the attack, showed a fine furry appearance, due to the many spore-bearing stalks of the fungus which protruded from the tissues of the host. The disease spread with startling rapidity. Often a single night or day sufficed to increase the affected area manyfold. The rapidity with which it spread, together with the apparent completeness of its destruction, entirely dismayed the average grower. The very evident necessity of attacking it at once was met by the lack of knowledge of what to do, or the impossibility of spraying large areas quickly enough or with sufficient thoroughness to check the disease.

All these facts seemed to indicate that the trouble would be very general and destructive to onions throughout the state. It was, therefore, decided that the entire time during a part of the season should be devoted to an investigation of this disease. It was hoped by this means to determine: 1st, the general distribution and prevalence of the disease throughout the state; 2d, the relation of location, soil, drainage, weather, etc., to the life of the fungus; 3d, its means of dissemination and perpetuation; and 4th, methods of successfully combating it. With these objects in view, onion growers in the different sections of

Western New York were visited and their fields inspected. It is true that there were many large growers not visited, but reports and rumors from many of these indicated that most of them were troubled more or less by the disease. Of the fields visited, only one or two appeared to be entirely free from the blight. It is very likely that even these fields were effected to some extent later in the season. The fact that the disease usually attacks the tops about the time that the bottoms are maturing, has led many growers to believe that this early dying down of the tops is due to the natural ripening of the onions. For this reason it was hard during the later visits to convince the growers that their onions had the disease.

While the distribution of the disease throughout the territory visited was general, there was great difference in its severity in different places. In the field of W. A. Culver, the disease appeared early. This field was well drained upland. The onions stood thick on the ground and Mr. Culver estimated, before the blight attacked them, a yield of 5,000 bushels for the five acres. A week later, on my first visit to the place, although the onions had much recovered, he told me that he did not then expect half that amount. Almost every onion had been attacked. Careful searching up and down the rows revealed only two or three apparently healthy onions. The blight again visited this field after the onions had largely recovered from the first attack. The second attack was worse than the first and put a stop to all further growth of the onions. The field had been planted to onions the previous year (1902) and they had been blighted. The disease had attacked them nearly a month later than during the present year and after the bottoms were well formed, so that the damage was comparatively slight. The larger part of the blighted tops of the crop of 1902 had been left on the field and this accounts to some extent, as will be shown later, for the severity of the disease during the present year.

Bonney & Ware of Batavia had but three acres of onions. This was on muck land that had been cleared the year before and had produced a single crop of celery. Onions had never been grown on or near this land. However, blight was found among them. The onions stood thick. The tops were strong and healthy. The land was low and conditions seemed favorable to the parasite, yet the blight appeared only in a few spots along one side of the field. These spots were thoroughly sprayed at once. The disease did not spread to any great extent and little damage was done.

On the farm of W. B. Howard near Fulton, Oswego county, the story of the disease was much the same as that at Mr. Culver's. Here the onions were on muck, low and not well drained. The land was so level that it was impossible to get sufficient fall for drainage. The onions were not so thick on the ground as at the other places mentioned. The blight here came nearly a month later than at Mr. Culver's. The onions too, had been sown later and were scarcely more than one-fourth grown when first blighted. In the opinion of Professor Rowlee, who was spending his summer on this farm, the bulbs never grew after the first attack of the blight, so that the crop was reduced at least three-fourths. The disease was fully as severe on the farm of Peck Brothers of Fulton and on that of Powell & Smith of Syracuse. In the case of Powell & Smith, however, only parts of the field were affected and the degrees of severity differed considerably even in the affected parts. In some spots the destruction was quite complete, while in others the blight did apparently little damage.

The onion fields about Canastota are all on low-lying muck lands for the most part well drained and long under cultivation. A large number of fields were visited, the largest belonging to any one party being perhaps that of Mr. Fred Twogood, about forty acres of whose farm was in onions. The blight throughout this district, while general, few fields being entirely free from it, was not so severe as in other sections of the State. A few small patches showed it in its worse stages, the tops practically all dead or dying. The lateness of the season at which the blight became prevalent in this section was very favorable to the growers. The bottoms were well formed and the growers were inclined to regard the dying down of the tops as the natural maturing of the onions.

On the whole, the disease was very severe throughout the districts visited and loss due to reduction of the size of the bulbs (to be discussed later) was considerable. Many farmers declared that the growing of other crops must be undertaken on these lands unless some means of checking the ravages of the disease is discovered.

THE DISEASE IN THE STATE IN PREVIOUS YEARS.

Inquiries brought out the fact that the disease was not new to the onion growers of the State. Several remembered some previous year in which the same disease had been quite as destructive as during the present season. Some of the more observant declared that it occurred every year more or less, but usually so late in the season as to do little apparent damage. This seemed to be borne out by the fact that the early dying of the tops had come by many to be regarded as the normal ripening of the onions. The fact that the disease was most general and severe on those lands previously devoted to onion culture, seemed also to support these observations. Mr. Culver, especially, had observed it in his field during the season of 1902, and had made some effort to eradicate it by pulling the tops in the spots first affected and burying them. In general the information regarding its occurrence in the State previous to 1903, as obtained from growers, is rather indefinite. None of them seemed to be acquainted with the true nature of the disease and though it was often referred to as smut, blight, "wet weather," etc., it is evident from their descriptions that it was the blight that had caused the trouble. Professor William R. Dudley, formerly of the Cornell University Agricultural Experiment Station, reported it as having been common in the vicinity of Ithaca

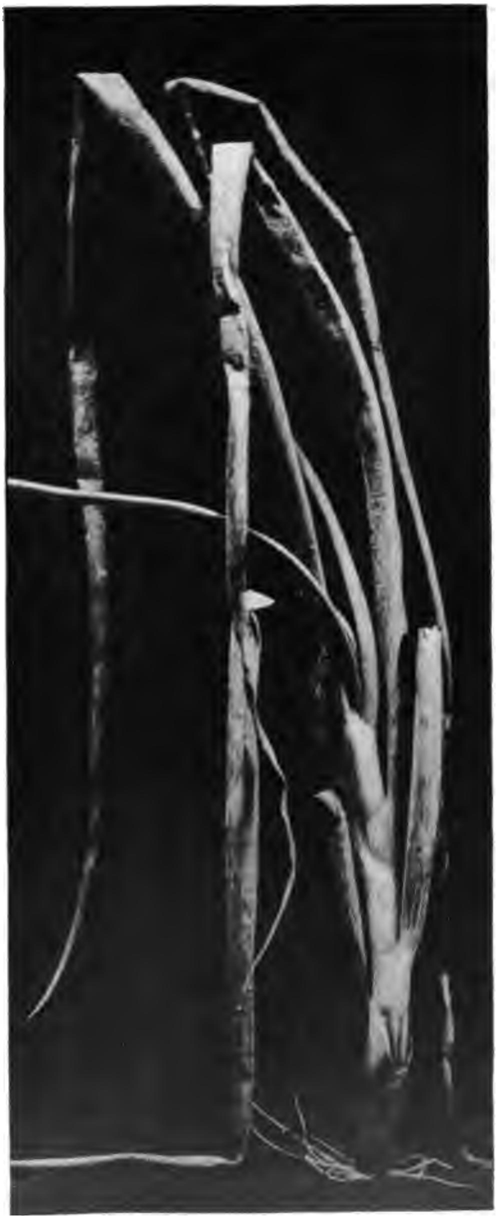

FIG. 3.—*Onion blight. Worst stage. Fungus at its best. Two new inner leaves just appearing, not yet affected.*

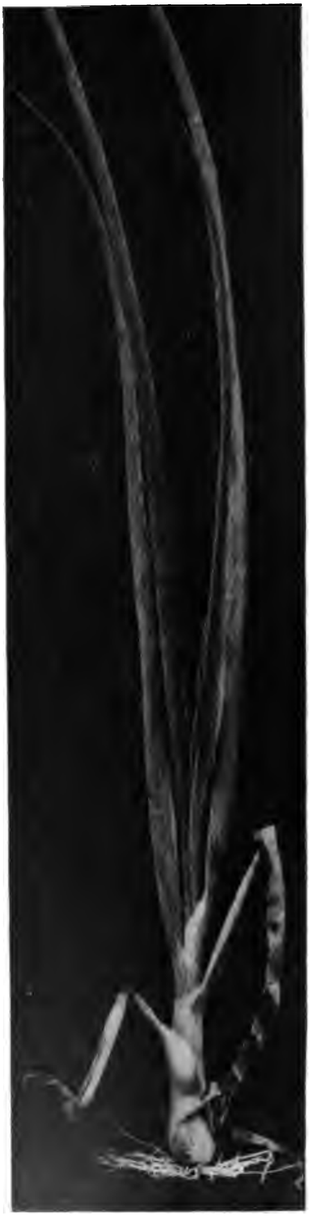

FIG. 4.—*Onion top recovered after first attack. Lowest leaves dead. New growth abundant, erect.*

during the season of 1888. It would thus appear that the blight has occurred very generally during the previous seasons and with considerable severity in some cases. The fact that it does not directly affect the bulbs as does smut or maggots, has caused most growers to attribute it to some natural or climatic condition, and so they have not regarded it as serious. Only when it came early in the season and the damage was severe and marked did growers regard it as a disease.

HOW THE DISEASE AFFECTS THE ONION.

How to recognize the disease upon its first appearance is one of the important things for the grower. After the fungus has spread over the entire field and the onion tops are dead or dying, it is no difficult matter for anyone to see that something is wrong. The rapidity with which the disease spreads demands that there be some sign by which we may discover the disease in its earliest stages and so be better enabled to cope with it. Unless the crop of the previous year had been badly infested the fungus first appears on a few onions in one or more parts of the field. The first "muggy" weather of July or late June should be the signal for a general looking over of the fields to discover any infected plants. The examination is best made in the early morning while the dew is still on the onions. A diseased leaf is then easily discernable at a considerable distance. Parts of it will appear of a peculiar violet tint, due to the furry covering of the fruiting parts of the fungus. These will stand out very abundantly and plainly on account of the moisture. Later in the day the parts are more or less collapsed by the drying of sun and wind, and the diseased leaf is more difficult to see. Aside from this peculiar furry violet appearance, the affected leaf is at first like the healthy ones about it. By the second day it has begun to lose its bright color, being paler or even yellowish in spots, where the disease first started. It will now be mouldy or furry throughout most of its length and by the third or fourth day collapsed and broken over. The fungus usually appears first on one side of the leaf about midway between its tip and base, from which it spreads rapidly through the entire leaf. Unless

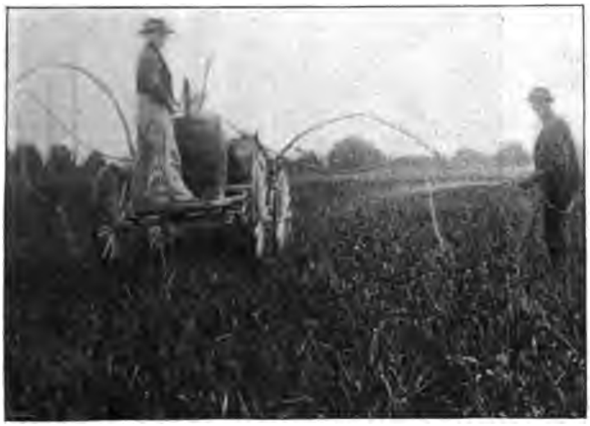

FIG. 5.—*Spraying with Bordeaux mixture for onion blight on the farm of J. Howard, near Fulton, N. Y. A little nozzle attached to the end of a 25 ft. hose. Two lengths of hose to the same pump. A strip 30 rows wide could be sprayed at one time. Swinging the hose from the ends of the poles which worked in a socket, saved the cost of two men. This apparatus was planned by Prof. W. W. Rowlee.*

the weather is especially favorable the disease will not spread over the field rapidly, but areas several feet in extent will first be evident, here and there through the patch about the places which were first attacked. Fig. 1 shows such a spot several days after infection had first occurred. The tops have gone down badly, largely from the weakening effects of the fungus. Fig. 3 shows an onion at the acute stage, taken from such a spot. After several days the affected onions begin slowly to recover. New leaves appear. These replace the affected ones which are drying up. If weather conditions are favorable to the onions this new growth is rapid and often in a week the field appears almost as thrifty as ever (Fig. 2). The affected leaves have quite dried up and disappeared while the new growth is erect and green. (Fig. 4.) The ability of onions to recover from a severe attack was shown to an extraordinary degree in the field of Mr. Culver. On July 13th he brought specimens to the laboratory in the condition of the one shown in Fig. 3. He said that the tops were all down and that they looked as if they had been drenched in boiling water. The disease was then at its worst. A week later,

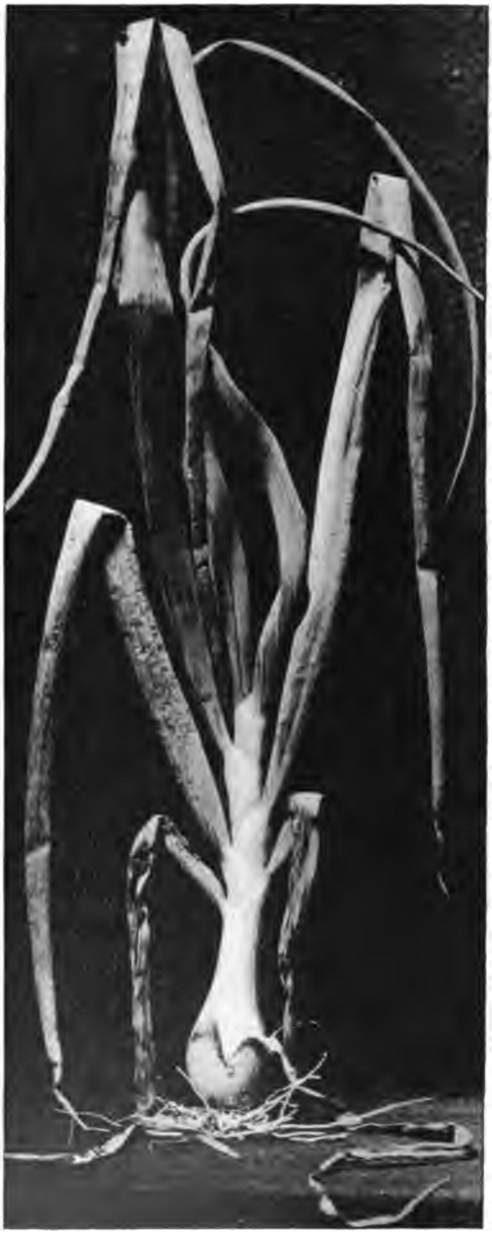

FIG. 6.—*Onion blight. A second attack. Lower dried up leaves killed by first attack. New growth which was strong and vigorous now affected. Leaves becoming weak, due to collapse of tissues.*

July 21st, I visited the same field. I was surprised to find the onions erect and green with little traces of the apparent devastation of the previous week. A closer inspection, however, disclosed the fringe of dried leaves on either side of the row along the ground and here and there a few green leaves showing traces of the fungus. The onion, shown in Fig. 4 was gathered at that time and is typical. Fig. 2 shows a part of Mr. Culver's field at the time of the first visit, one week after the first attack had been at its worst. Scarcely any trace of the disease can be seen in the photograph. Fig. 5 shows a badly affected field, the tops are nearly all affected and breaking over. The rainy weather during which the disease was first so destructive in Mr. Culver's field was succeeded by bright warm days with considerable wind, just the best growing weather for onions and the most unfavorable to the disease. It must always be remembered that weather conditions are a great factor in the recovery of the onions. The blight, of course, never entirely disappeared from the field and with the return of wet weather about August first, the fungus again spread over the entire field, attacking and destroying the new growth of leaves. On the second visit, August 11th, I found the onions in very bad condition (Fig. 6). The tops were down and the entire field had a sickly yellow color. The onions never recovered from this second attack.

The story of Mr. Culver's field is to a large degree the story of every blighted onion field. If the first attack comes late in the season the onions will likely never recover at all. If weather conditions remain favorable to the fungus the new growths are affected as fast as they mature. It was discovered that young onions and rapidly growing leaves, however, were not so liable to infection. Leaves which had reached maturity or those weakened by breaking or by the ravages of thrips seemed most easily infected by the fungus. This accounts for the rather late appearance of the fungus. Apparently onions are the most susceptible about the time the bottoms begin to form, after the leaves are for the most part done growing and are devoting their energies to the making of the bulb. Our observations were for the most part on onions grown from the seed. Some seed onions were seen but no blight was observed on them. Thaxter, in 1890, reported blight as occurring only on seed onions, while onions next to them, grown for market, were not affected. Fifty per cent of the seed in this case did not mature.

As this disease does not disfigure the bulbs or destroy them as smut or maggots do, growers are not likely to consider it as a very serious trouble. Besides, the disease does not often become serious until the onions have attained considerable bottoms, and so the grower is deceived as to the amount of injury done. It is, of course, the growth of the leaves that is directly affected.* The nutrition which should have gone to the growing part of the leaf and bulb is largely used up by the parasite. The leaf is the part that takes the plant-food that is brought up from the soil in solution in the sap, and the carbon dioxid from the air and manufactures the substances of which the bulb is composed. It is the important part of the onion during the growing period. No grower would expect bulbs to form on plants from which the leaves were removed as fast as they were formed. Neither would he expect onions to attain the proper size if the tops were cut away when the bottoms were half formed. This very thing is what practically takes place when onions are severely blighted. The entire working part of the onion is disturbed and destroyed. Growth of the bulb must of necessity stop. A new growth is then necessary and the energy of the plant is directed to that, while growth of the bulb ceases. As have already shown, this new growth has scarcely attained sufficient size and maturity to take up the bulb building work again when it is attacked by a second epidemic of the blight. Even if the most favorable conditions prevail, the time lost during the acute stage and the recovery means a considerable reduction in the amount of bulb produced. It is the reduction in the size of the bulbs that we wish to emphasize as the chief effect of the blight. Usually little or no increase in the size of the bulb takes place after a severe attack of the fungus. If the attack comes after the bulbs are half formed this means the loss of one-half the crop. Conservative growers this year estimated that their yield per acre was reduced one-fourth to one-half by the disease. This meant a loss of many hundreds and even thousands of bushels. Undoubtedly this disease often reduces very materially the onion yield in the State of New York. Growers have come to regard 400–500 bushels per acre a good yield, yet every grower knows that 700–1000 bushels is not an uncommon yield under favorable conditions. This difference between the ordinary yield and that which is possible I believe to be due to a considerable extent to the blight. It certainly was so during the past season. Maggots and thrips do their share. On muck lands light stands often occur as the result of the blowing out of the seed during the dry weather at planting time. However, in those cases where the stand is strong and even much larger yields would be realized if the blight could be controlled.

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* The conidiophores choke the stomates and prevent the circulation of the air. The haustoria or suckers which penetrate the leaf cells suck out the sap and nutrition of the cell. The cells are thus very much weakened and finally killed. They lose their plumpness and collapse, causing the leaf to break over and shrivel up.

There is another disorder or appearance of the onion that sometimes alarms the grower, but which is really only the work of a secondary fungus that thrives on plants that have already been weakened by the blight. This secondary fungus is a kind of mold or mildew, giving the leaves a black or sooty appearance. It is described more fully in Part II (page 149).

TREATMENT.

The question of how to control this disease is the all important one to the grower. Two ways present themselves: first, by checking the disease after it has once started in the onions; and second, by preventing it from getting a start. As is usual the former is the more difficult of the two. We have seen that the fungus lives within the leaf tissues of the onion sending forth only the conidia bearing stalks. It is very evident then that when once the mycelium is started in a leaf, *i. e.*, when once the leaf is infected, poisons applied to the surface have no effect on the fungus within. So far as the infected leaf is concerned it is doomed. If the disease has spread over a large part of the field, the vast majority of the leaves will have been affected. We cannot hope to save those leaves. They will certainly be killed. Evidently then the only way to handle the blight is to prevent the infection of the onion leaf by the fungus. Preventative measures are numerous and effective, depending upon the time at, and the conditions under which they are applied.

Killing the fungus.—What is to be done when once the disease has spread over the entire field? If weather conditions are at all favorable a second growth of leaves will be produced. Should the attack come early in the season, say July first, this new crop of leaves could do much toward producing a normal yield of bulbs. It is desirable in such a case to protect this new growth if possible. Experiments in spraying by growers throughout the State during the past season did not seem to be very successful in accomplishing this. I believe, however, that this is possible, and wish to point out that in no case did the grower spray more than once. In most cases where spraying was done, the spray was applied thoroughly and satisfactorily. Standard Bordeaux mixture was used. A second application was never made although the necessity of it was urged if good results were to be obtained. In many cases the disease appeared to have been checked by this single application, but with the return of damp muggy days, the spores produced anew from the mycelium within the sprayed leaves, spread to the new unsprayed growth and a repetition of the former devastation occurred. If this new growth had been kept thoroughly sprayed, the spores falling upon the poisoned surface would have perished at once and infection have been rare. In badly infected fields spraying can only be expected to protect the new growth and uninfected leaves. Where the blight is only present in spots, a thorough spraying of these spots to kill all spores in order to prevent infection of uninfected areas is to be strongly recommended. A single application, as already pointed out, will not be sufficient. The number of applications and the time at which they are to be made will depend upon weather conditions almost entirely. If there are clear sunny days and plenty of breeze and no dew at night, the disease will not spread and a second application will not be necessary. As such conditions will almost never continue for any length of time, it will be necessary to spray every few days. If damp cloudy weather prevails spraying should be done at least every ten days; oftener is advisable. The new growth should always be sprayed as soon as it has attained considerable size no matter what the weather may be. If the crop is attacked, *spray with Bordeaux mixture: watch the plants closely, and spray again if the disease is not checked.*

Preventing the disease.—So far methods of attacking the disease once it has appeared in the field have been discussed. Since the blight fungus is so generally distributed throughout the State and nearly every grower may be expected to be troubled with it, measures for preventing or controlling it should be begun early in the season. This probably will be found to be most successfully accomplished by *systematic spraying*, *beginning the latter part of June or the first of July*, *and continuing throughout the season*. This has been used very successfully by onion growers in Europe. Mr. Beech, of the Geneva Station, reported this as successfully used by onion growers in this State some years ago.

Two things are always to be insisted upon in applying the spray: 1st, thoroughness; every side of the leaf must be covered. 2d, force; the mixture must be applied with sufficient force to make it stick to the smooth surface of the onion leaves. A nozzle that gives a fine spray should be used. One of the most successful spraying machines that I have seen is the one shown in Fig. 5. Mr. Culver used a machine in principle very similar to this. The Bordeaux used was mixed in the porportion of four pounds of lime and six pounds of blue vitriol (copper sulfate) to a barrel of water. It was found that in some cases this seemed to burn the leaves. A larger proportion of lime would very likely obviate this trouble. A reduction of the strength of the solution has also been recommended.

We have seen that *location and drainage have much to do with controlling the blight*. Properly drained lands are less liable to the disease than wet ones. All barriers, such as, tall weeds along ditches or the sides of the field should be removed so as to admit the air freely to the growing onions, thus assuring the rapid evaporation of dews and rains. Lands for onion fields should be chosen in places as much exposed as possible. Swamps surrounded by high hills are especially unfavorable.

We have now considered the means of attacking the fungus in the summer stage. There remains to be considered the winter stage. Since the summer stage which is the destructive one, perishes with the approach of winter, it is evident that if the resting spores by which the parasite manages to pass the winter could be destroyed the disease could not reappear the following season. These spores, as we shall see, pass the winter in the dead leaves of the onion. These leaves are usually left on the field. Even where they are most carefully raked up and burned large numbers of oospores must still remain in small broken pieces of leaves which cannot be removed. *The raking and burning of the tops is to be strongly recommended*, *as in this way a large part of the resting spores are destroyed*. *The practice of throwing tops and decaying bulbs back on the field or on manure piles cannot be too strongly condemned*. It has been suggested that the burning of a layer of straw scattered over the field just after the removal of the onions would kill these spores. No doubt it would materially aid in reducing their number. To my mind the most feasible method offered, however, is the sterilizing of the upper layer of the soil with steam and hot water by means of an especially devised apparatus. This is said to have been successfully used in destroying weed seed, insects and fungi. The most promising machine for this purpose yet put upon the market is one invented and manufactured by Mr. Luke Kavanaugh, Waterford, N. Y. It would be well if the efficiency of this machine in destroying fungus spores could be tested.

Since it is believed that these resting spores retain their vitality for two or three years it is advisable, where blight has been very severe, to *try rotation of crops.*

The necessity of great care to prevent infection, by these spores, of lands free from blight and those planted to onions for the first time cannot be too strongly emphasized. I think it is generally by the resting spores alone that a field becomes infected, unless there are infected fields immediately adjoining it. The short period of vitality of the summer spores and their susceptibility to the drying effects of the wind seems to show that they never convey the disease to any great distance.

In the case of many fungous diseases certain immune or resistant varieties of the host plant occur or have been developed. For example, certain varieties of the apple are entirely immune to the apple rust, so destructive to other varieties. Shipley observed that the red varieties of onions were apparently least affected by the blight. My observations seem to confirm this. Although the red varieties seemed always to be affected in fields where white onions were diseased, still they did not seem to suffer to such an extent. It is possible that by careful selection a variety of onions might be obtained that would be immune to the disease.

Anything that tends to weaken the onions in any way, as too much moisture, shelter or transplanting invites the disease and should be guarded against. *Thereis little danger of introducing the disease through the seed if the seed is perfectly clean of bits of leaves or stems which might harbor the spores. As a precautionary measure, seed might be treated with formalin. Soak from one-half to one hour in a .5 per cent (½ of one per cent) solution of formalin before planting.* This will prevent the introduction of onion smut also.

PART II. A MORE TECHNICAL ACCOUNT OF THE ONION BLIGHT, AND OTHER DISEASES.

THE FUNGUS,—ITS NAME AND LIFE HISTORY.

The fungus which living as a parasite in the tissues of the onion leaf causes this disease was first described and named by Berkley (1841). He called it *Botrytis destructor*. Unger (1847) described it as *Peronospora schleideni* Shortly after Berkley had first described and figured the parasite, Schleiden (1849) described it referring it to the species *Botrytis parasitica*. In Berkley's Outlines of British Fungology, 1860, it is listed as *P. destructor* Caspary. What Berkley's authority for the use of that name is, I am as yet unable to determine. Later De Bary (1863), while revising the genus changed the name to *P. schleideniana*. This name has perhaps been the most generally used, and especially in recent literature. It is, therefore, retained in this paper.

P. schleideniana, like most species of the downy mildews, has two quite distinct stages in its life history: 1st, the vegetative or conidial stage by means of which the fungus disseminates itself and during which it is most destructive to its host This stage flourishes only under the most favorable conditions: 2d, the sexual or resting stage which appears at, or toward the close of the conidial stage. It is by means of this stage that the parasite is carried over long periods of unfavorable conditions, viz., winter, drought, lack of food supply, etc. We will now consider these two stages in detail. This will help us to more intelligently discuss the various conditions of weather, location, etc., affecting the fungus at different times in its life and so enable us to combat it with some hope of success.

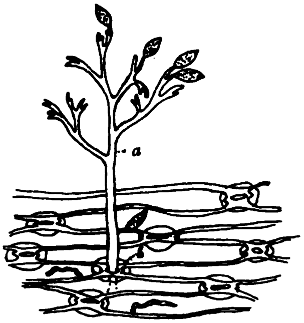

FIG. 7.—*A part of the epidermis of an onion leaf with conidiophore* (*a*) *protruding from the stomate* (*b*.

The conidial stage.—If a badly affected onion leaf is carefully examined with the naked eye it will be seen to be covered in places with a dense mouldy growth, which from its peculiar violet tinge is often discernable at a considerable distance. Examination of this with a hand lens shows it to be due to innumerable erect branched threads, which appear not unlike so many tiny trees standing out from the leaf. These stalks are themselves colorless, but on the ends of many of the branches will be seen little egg-shaped bodies, the conidia or spores. These bodies are the "fruits" of the fungus, the spores by which it reproduces itself. One of these conidiophores, bearing conidia and much enlarged is shown in Fig. 7. Further examination shows that the conidiophore comes from within the tissues of the leaf.

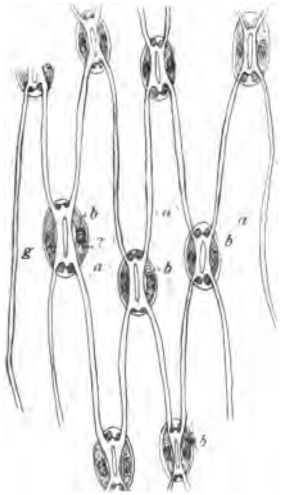

FIG. 8.—*A part of the epidermic of a healthy leaf, much enlarged.* (*a*) *The long cells. b, b, The stomates. g, g, guard cells of the stomates.*

In order to understand how the parasite lives within the tissues of the host, it is necessary to see what the structure of the onion leaf is. With the thumb-nail it is easy to scrape or peal a thin transparent layer from the surface of the leaf. This is the skin or epidermis (Fig. 8) and is composed of a single layer of long cells between the ends of which are peculiar round structures with a slit or opening through them. (Fig. 8b, b.) These are the stomates or breathing pores of the leaf It is through these that the air passes in and out of the leaf and through these water is given off in the form of vapor. They are very important organs of the leaf, for through them alone is there connection between the inner tissues and the outside air. Two large guard cells (Fig. 8g, g.) one on either side, control the size of the slit according to the condition of moisture, etc.

If we split a leaf lengthwise and take a very thin slice from one of the edges, it will appear in the microscope as in Fig. 9. The cells of the epidermis with the guard cells cut through edge-wise form the first or outer layer (a). Just beneath this are rather long sack-shaped cells with their long axes at right angles to the epidermis to which they are fastened. They are arranged very loosely, often not touching each other at all (Fig. 9b). These are the palisade cells. Their inner ends are fastened to loosely arranged cells of the same sort, but which are more or less globose and in one or two layers, (Fig. 9c). These three layers of loosely arranged cells contain most of the chlorophyll of the leaf and are known collectively as the mesophyll cells. These are the cells in which the food of the plant is manufactured from the raw materials brought to them. Their loose arrangement leaves many intercellular spaces. These are connected with the openings of the stomates, (Fig. 9d). This allows free circulation of air among the mesophyll cells, which is quite necessary in some of the work that the leaves do. Next to the inner mesophyll cells are several layers of large oblong cells, which in section look not unlike brick work, (Fig. 9e). Their long axes are parallel with the long axis of the leaf. These cells contain but little chlorophyll. Their chief function is to conduct liquids back and forth.

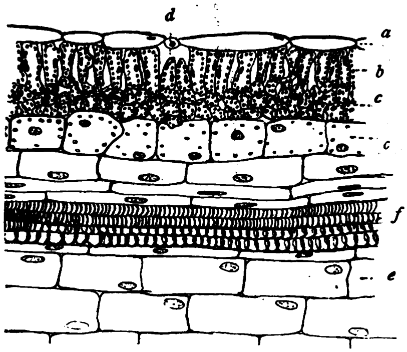

FIG. 9.—*Longitudinal section of a healthy onion leaf. (a) Epidermis; (b) palaside cells; (c) lower layers of the mesophyl cells; (d) air chamber beneath the stomate; (e) large conductive cells; (f) fibro-vascular bundle.*

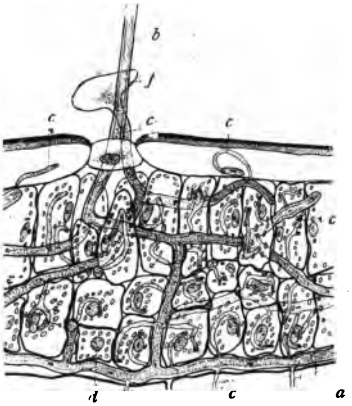

FIG. 10.—*Longitudinal section through a portion of a diseased leaf; (a) mycelial threads of the parasite; (b a conidiophore, the continuation of one of the internal mycelial threads; (c, c, c) haustoria; (d) nucleus of the host cell; (e) germ tube of the conidium; (f).*

If a similar section to the one already described is made through a diseased leaf (Fig. 10) many fine, almost colorless threads (a) will be seen to wind their way through the intercellular spaces among the mesophyll cells, branching frequently. They even push through between the closely packed conductive cells (Fig. 11). These threads are the mycelium of the fungus. By following one for some distance it will at length be seen to pass out through one of the stomates (Fig. 10b), giving rise to one of the conidiophores as already described. Different stages in the formation of these conidiophores are shown in Fig. 12. At first they are but the ends of these mycelial threads which, as they near a stomate, (Fig. 13) turn and grow out through it. Soon they branch to form the mature conidiophores (Fig. 14).

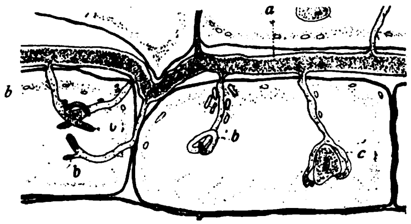

FIG. 11.—*Mycelial threads between the large conductive cells of the leaf; (a) the mycelial thread; (b, b) branched or coiled haustoria; (c) branched haustorium wrapped about the nucleus.*

The mycelium, in order to grow and spread through the leaf, must obtain nutriment in some way from the host. As the threads wind about among the cells they send off smaller short branches that penetrate the walls of the host cells (Fig. 10c) and (Fig. 11b). These usually branch once or twice within the cell. These suckers or haustoria, as they are called, absorb the sap and nutriment of the cells and conduct it to the growing mycelium. In badly affected leaves every one of the mesophyll and conductive cells has one or more of these haustoria in it (Figs. 10 and 11), sucking up the food substances which the cells need for their own growth and activities. Every cell (Fig. 10) of the leaf has a small body within it, denser than its other contents. This is called the nucleus (d) and is the most vital part of the cell. Often the ends of these haustoria wrap themselves closely about the nucleus (Fig. 11c).

The conidia or spores, as shown in Fig. 12, are formed at the end of the branches of the conidiophore. They begin as little swellings at the tips of these branches (Fig. 12a). These gradually enlarge until the mature spore is formed, which is then separated from the branch by a thin wall. These conidia are egg shaped (Fig. 14b) and quite sharply pointed at one end. They are about 45-58 x 20-25μ* in size. The walls of the conidia are of a pale violet color and very thin. The wall encloses a mass of protoplasm, the living part of the spore. These conidia are very light and very loosely attached to the branches when ripe. They are blown about to healthy leaves of neighboring plants by the slightest breeze. If they chance to fall into any bit of rain or dew which clings to the leaves they germinate at once, sending out a small thread-like tube from one side (Fig. 14c), which seeks a stomate (Fig. 14d).

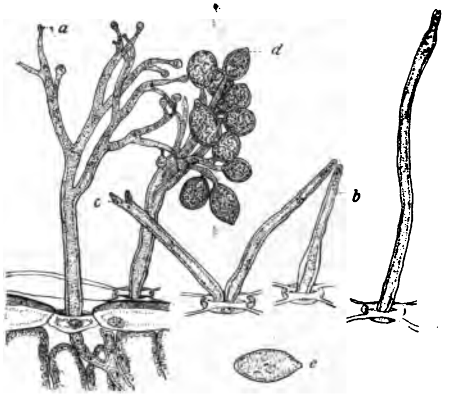

FIG. 12.—*Different stages in the development of the conidiophore and conidia. (a) tip of a branch swelling to form a conidium; (b) conidiophore just emerging from a stomate; (c) conidiophore just beginning to branch; (d) conidia nearing maturity; (e) mature conidium.*

This tube grows through the opening of the stomate into the inter-cellular spaces of the leaf and gives rise to mycelial threads (Fig. 10e) whose haustoria, (Fig. 10c, c) entering the cells of the host, supply the young mycelium with food. It grows rapidly, and spreading through the leaf, soon sends forth conidiophores bearing conidia. These are scattered to other leaves and the process of infection and growth is repeated indefinitely. The entire process requires but a few hours or a day at most, and hence the rapid spread of the disease. The conidia are short-lived and lose their germinating power in a very short time.

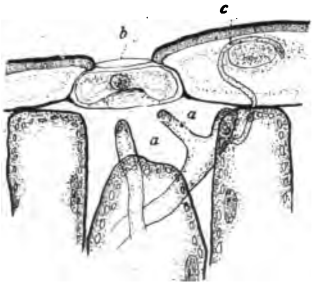

FIG. 13.—*Young conidiophores. (a, a) turning toward the stomate; (b); (c) haustorium wrapped about the nucleus of the epidermal cell.*

Sexual stage. - A microscopical examination of a badly affected leaf will often show numerous globose bodies scattered through the tissues. These are the *sexual* or *resting spores* (Fig. 15). They are rather large globose bodies about 30μ in diameter. They are always formed within the tissues of the host while the conidia as already shown are formed without. Some of the short branches of the mycelium swell at the end and as this swelling enlarges it is filled with a dense mass of protoplasm, the living substance of the mycelial thread (Fig. 16). The *oogonium*, as this enlargement is now called, has a single thin wall, and its protoplasm is granular and almost colorless. About this time another mycelial thread grows up along side the oogonium. The end of this thread swells slightly but in a rather irregular form and remains much smaller than the oogonium (Fig. 17b). The contents of this swollen tip also becomes dense and granular. This is the ***antheridium*** and contains the fertilizing sperm.

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*A *u* equals 1-2500 of an inch.

The antheridium now applies itself closely to the surface of the oogonium. A cross wall is formed at the base of both the oogonium and antheridium cutting off their contents from the rest of the thread (Fig. 17c). The contents of both the organs now contract and become denser, leaving a clear colorless region between the wall and the central mass. This central mass of the oogonium is the *oosphere* or egg. A small tube grows out from the antheridium, penetrates the wall of the oogonium and extends into the egg (Fig. 17d). The contents of the antheridium pass through this tube and unite with the contents of the egg, which is now said to be fertilized and is called an *oospore* or fertile egg. Changes now begin to take place in the oospore. It surrounds itself with a thick wall, which when the oospore is ripe, is of a pale brown color. The wall is smooth, the contents granular and usually with several large oil drops. The oospore (Fig. 15b) formed in this rather complicated manner, is of the utmost importance to the parasite, for upon this spore the fungus depends to be carried over until the next season. The wall of the oospore now thickens and the protoplasm becomes dense and oily. It is thus enabled to withstand great extremes of cold, heat and moisture, conditions under which the conidia would quickly perish.

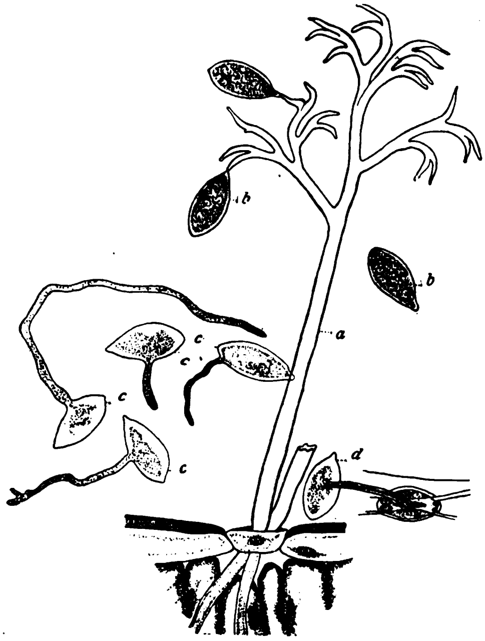

FIG. 14.—*Mature conidiophore* (*a*) *with mature conidia,* (*c, c*); (*d*) *germ tube of conidium entering stomate.*

These oospores are formed in great numbers, as an examination of a dead and dried up leaf will show. The dry leaves are easily broken from the onion in gathering and lie on the ground during winter, decaying more or less. Onions are usually planted again on the same field the next spring. The oospores in these decaying leaves germinate under favorable conditions and infect the young onions giving rise to the disease again. Thus the life history of the parasite is completed.

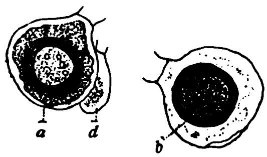

FIG. 15.—*Oospores.* (*a*) *mature oospore with old antheridium,* (*d*) *still attached;* (*b*) *mature oospore still enclosed in the old wall of the oogonium.*

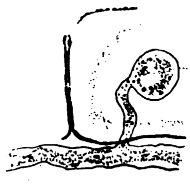

FIG. 16.—(*a*) *young stages of the oogonium.*

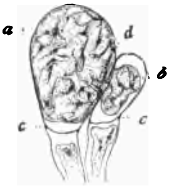

FIG. 17.—*Oogonium and antheridium at the time of fertilization.* (*a*) *oogonium;* (*b*) *antheridium;* (*c, c*) *septa cutting off the sexual organs from the mycelium;* (*d*) *fertilization tube.*

CONDITIONS AFFECTING THE LIFE OF THE PARASITE.

Having discussed the different stages in the life history of the fungus, let us now examine the external conditions, which affect the parasite during these different periods. Weather conditions are perhaps the most important in determining the extent and severity of the disease. The general opinion of observers seems to be, that warm, damp weather with continual rains or heavy dews is the most favorable to the fungus. Observations during the past season seem to confirm this opinion in most respects. During the spring and early summer of 1903 there was a long severe drought. Then followed for the remainder of the onion season much moist rainy weather. Shortly after the rains and heavy dews set in, the blight began to appear in the onion fields throughout this part of the State, indicating that moisture was one of the prime requisites for the development and spread of the fungus. It was noted that the blight occurred periodically during the season. This agreed exactly with the periodical occurrence of damp rainy weather. Professor Rowlee observed that the most serious outbreak in the onion fields about Fulton occurred during the heavy fogs to which that section is much subject. He states that this has been repeatedly observed by onion growers in that region. Potato blight (*Phytophthora infestans* De Bary) he also observed to be periodic, due to the same cause. Apparently temperature does not affect the spread of the fungus to such an extent as observers heretofore have intimated. Professor Rowlee reports that the disease was worst during the coolest weather of the latter part of August and the first days of September, and my observations confirm this. The most abundant germination of conidia was observed on onion leaves during the coolest days of the season. It has long been observed that sun and wind are unfavorable to the fungus. While at Bonney & Ware's there were two heavy rains followed immediately by hot sun and a strong breeze, which dried the onion leaves in a very short time. Although there were several infected spots in the field the sudden removal of the moisture seemed to prevent the spread of the disease and the infected patches did not increase much in area.

Another important factor is the location of the onion field. Onions on low lands with *poor drainage* are almost sure to suffer. The constant evaporation going on from such lands gives a sufficient humidity to the air except in very dry weather, to permit the growth and spread of the fungus. The growth of the tops is usually more abundant on such lands, thus allowing less circulation of the air and consequently a slower removal of moisture. Muck lands are, of course, most liable to this trouble. Moreover most of these muck lands are low lying, *i. e.*, they are surrounded by rather high hills, which shut off the winds to a considerable extent. The moisture due to heavy dews, fogs or rains, is not rapidly removed and the fungus finds here the most favorable conditions for growth. Often portions of the swamp not under cultivation are covered with trees and shrubs, thus forming a very efficient barrier to the wind. The more exposed the onion field the less danger there is of blight. It was found that the onions in these muck lands were generally planted in small patches and separated by open ditches. In most cases the banks of these ditches were grown up with tall weeds which acted as barriers to the wind. It was often observed that the blight was much worse in the onions next to these weedy barriers. Away from the ditch where the wind could get at the onions the blight was less severe.

The onions should be kept clean of weeds as they prevent free circulation of the air. On rich muck lands there is apt to be a heavy succulent growth of tops. These are easily broken over by hard rain storms and go down. This not only prevents the evaporation of moisture but weakens the tops, making them more susceptible to the attacks of the parasite. Some splendid examples of these "down spots" were observed in the field of Bonney & Ware. (See Plate I.) In this field the blight seemed to be confined almost entirely to these spots.

DISSEMINATION AND PERPETUATION OF THE FUNGUS.

The conidia or spores, as they are called, are the means by which the fungus spreads from plant to plant. These spores being so very small and light are easily carried to a considerable distance by the slightest breeze. The great numbers produced insure a very thorough distribution of the disease over the immediate neighborhood of the affected plants. Mr. Shipley (1887) estimated that there are 70,000 stomates to every square inch of an onion leaf. In badly affected leaves he found that from at least one in every ten of these stomates a conidiophore protruded, sometimes two or three from a single stomate. Each conidiophore bears about 20 conidia, making 140,000 conidia to each square inch. This will give some idea of the vast number produced on a single diseased leaf.

These spores, as already observed, are very short-lived, much shorter lived, I believe, than has been generally supposed. Shipley (1887) stated that if the conidia dried up they would retain their germinating power only a day or two, but if the weather was favorable and there was plenty of moisture they would germinate after several weeks. Other observations, together with mine, do not seem to agree with this. Jones (1897) found, that the time necessary for bringing affected onions from the field to the laboratory, was sufficient for the loss of germinating power of the conidia. He kept the onions in a moist chamber over night and succeeded in growing a new crop of conidia which germinated readily the next morning.

I obtained germination of spores on two occasions. The first time at the home of Mr. Howard on our trip to Fulton. There the onion field was but a short distance from the house. The onions were brought home during a drizzling rain while the conidia were forming rapidly. Drop cultures in fresh rain water were at once prepared. These showed spores already germinated, though many germinated after the cultures were made. The second successful germination was of conidia obtained from diseased onions brought in from the Experiment Station Garden, only a few steps from the laboratory. This too, was on a cool rainy morning and fresh conidia were then being constantly formed, as was shown by the numerous stages of development of conidiophores and conidia, observed at that time. So abundant was the germination of these spores that almost every section from affected leaves showed germinating spores with germ tube entering stomata (Fig. 14d). From observations, I am inclined to believe that the germinating power of the conidia is not retained for more than an hour or so under the most favorable conditions and the drying out of the spore to any considerable extent seems to be fatal. This limited vitality period is made up for by the new crops of conidia, which under the proper conditions, are being constantly produced. The mycelium, as already shown, branches profusely throughout the intercellular spaces. As it spreads from the infection center new conidiophores are being constantly sent up through the stomates toward the border of the infected area. The warm sun and drying wind of the day may check their formation for the time but the mycelium within, unaffected by these external conditions, pushes out into the surrounding healthy tissue, sends its haustoria into new cells, and thus gets a good food supply which will be readily available. As soon as the dews or fogs set in, conditions become suitable and conidiophores in great abundance are sent forth from this internal mycelium through the numerous stomates of the recently infected tissue. Thus it will be seen that at each favorable opportunity, a new zone of conidia-bearing surface is added to the infected area. Very often these concentric rings or zones may be very clearly perceived by the difference in coloration from the center to the outside of the infected area. The tissues at the center, being first attacked, lost their green color soonest and appear yellowish. The different shades of green and yellow from center to margin are often quite abrupt and marked.

The great rapidity with which the disease will spread throughout a field leaving death and destruction behind is, to the grower, perhaps the most extraordinary feature of the blight. One grower whom I visited told me that his onions had no disease, but were looking fine, in fact, he had not had better prospects for a crop of onions in years. He had visited the field just a few days before. However, I asked if I might see the fields. He very courteously drove me over the field, some distance from the office. His surprise may be imagined when he reached the field to find those onions, which but two days ago were erect and green, now fallen over and faded. They looked as if scalding water had been thrown over them. No doubt at the time he looked them over, several days before, the disease was already in them but to such an extent that only the practiced eye would have discovered it. Two days of foggy, rainy weather had just preceded my visit and in that short time the disease had almost ruined a large part of the onions.

From almost every grower I heard the same story; erect and healthy onions one day, the next, large areas blighted and dying. The rapidity with which the fungus is desseminated throughout a field may be better understood when we recall the enormous and almost continual production of conidia. A single infected onion, undiscernable in a field of green healthy ones, will produce enough spores in a single favorable day or night to infect a very large area. Not only the numbers of conidia produced but the rapidity with which they germinate is largely accountable for this rapid spreading. I found that conidia germinated and sent out tubes of sufficient length to reach and penetrate the stomates in from 20 to 30 minutes after removal from the conidiophores. The mycelium within the host must also grow very rapidly in order to produce so great a number of conidiophores in so short a time.

Having discussed the means by which the fungus propagates itself during the growing period of its host, we may now see by what means it is enabled to pass the winter or other periods unfavorable to its growth and development. The earlier investigators believed that this fungus wintered as mycelium in the bulbs of the onion, and produced conidia again when the host was planted the following year. Although it is known that most of the Peronosporæ form oospores or resting spores, as they are sometimes called, they were apparently not observed in the case of this species until in very recent years. Trelease (1884) and Dudley (1889) both believed that the mycelium passed the winter in bulbs of affected onions. The fact that it often appears among onions grown directly from the seed, on lands not previously planted to onions, caused this opinion to be questioned. Shipley (1887) described and figured the oospores in onion leaves from Bermuda and concluded that by means of these the fungus survived unfavorable conditions. According to Jones (1895), who first reported them from this country, the oospores had before been observed in Europe. Whether they had been observed by investigators previous to the time of Shipley, I have as yet not definitely determined.

Careful examination of bulbs of badly infected onions throughout the past season showed in no case any trace of mycelium in any part of the bulb. It is possible that the mycelium may in some cases winter in this way, especially in bulbs more or less protected. It is at least not advisable to use blighted onions for sets for growing seed. The fact that onions through this section are grown, in nearly every case, directly from the seed and not from sets would seem to indicate that the disease must winter usually by means of the oospores. It is safe to say that by far the greatest number of infections are from these winter spores. This is supported by their very general and abundant production. They begin to appear in the tissues of the infected onions quite early in the season. I found them in diseased onions brought to the laboratory by Mr. Culver during the early part of July. However, only a small per cent of leaves then showed them. On the second visit to Mr. Culver's place, Aug. 11, a large number of the leaves showed the oospores. Jones (1897) believed that they were not formed to any great extent until late in the season and observations in the main confirm this. There were some instances, however, in which oospores were very plentiful in the old dead leaves killed by the earliest attacks.

These oospores, as we have seen, have a thick wall or coat and dense oily contents. This makes them very resistant to extremes of heat and cold. They are formed within the tissues of the leaf and do not escape from it. The leaves dry up and fall to the ground. Here they lie during the winter and in the spring decay, exposing the oospores within, which now germinate and infect the new crop of onions. In many cases the onion tops are left on the field and so, of course, the ground is thoroughly seeded with oospores for the following season. At Canastota growers told me that rotten bulbs, as well as tops, were thrown back on the fields. A very few growers raked and burned the tops. Just how long these oospores will live we cannot say. Shipley (1887) estimated that they will probably retain their vitality for two or three years. Jones (1897) found that soil brought from infected fields and planted to onions the next spring in the greenhouse, caused the disease to again appear, evidently from oospores in decayed leaves in the soil. Onions grown in soil from uninfected fields were not attacked. So far as I am able to learn, the germination of the oospores has not been observed in this species.

Several fields were visited during the past season on which onions had never before been grown. Still the fungus attacked them and was doing considerable damage. One case was especially noticable in this regard. I give it in detail, as it shows how easily soil may be infected and what great care should be exercised to prevent the contamination of uninfected fields. The field was that of Bonney & Ware of Batavia. The onions were planted on muck which had been cleared but two years. During the season of 1902 it had been planted to celery. Not an onion was grown in the swamp that season. The second season (1903) the onions were planted on three acres of the land, along the west side of the swamp, the side on which was the entrance to the field. No onions were grown within half a mile of the swamp and these not in the line of prevailing winds. The conidia could not have reached the field even if they could have survived the trip. It was evident then that the oospores must in some way have reached the swamp. So far as we could learn, wild onions which might have harbored the disease did not occur in the immediate neighborhood. After some questions, it was learned that during the season of 1902, Mr. Bonney had been interested in onions grown at E. Bethany, six miles distant, and had brought his share to his barns at Batavia in the fall of that year. Here they were cleaned and stored. The waste was thrown out in the barn-yard, through which the road to the swamp led. Several men and teams were employed during this time. It often happened that one day they hauled onions from E. Bethany and the next worked in the celery field (which was to be planted to onions the following season, 1903). The same wagons were used in the celery patch the next day. It was in the fall and the roads were more or less muddy. They passed through the barn-yard in which the waste from the onions was strewn. Mr. Bonney recalled that the blight or what he now believes to have been blight, was quite common on the onions at E. Bethany during 1902. It is very evident then that this was the source of infection. Pieces of leaves containing oospores were no doubt carried to the celery patch in the wagon boxes or on the muddy wheels, or even on the feet of the men and horses. Another thing seemed to prove that the conclusions in regard to the infection of this field were correct. The disease appeared at first entirely along the west side in the first few rows. This was just where the men, during the onion harvest, had worked with the celery on days they were not hauling onions. Farther toward the east where the celery had been banked later in the season after work on the onions had ceased, no blight occurred.

Several other cases of distribution were observed. This, however, will suffice to show how easily the disease may be transferred even for long distances to uninfected fields. I think that there is little danger of infection of fields by conidia from fields a half mile or more away, and that most cases can be traced directly to the introduction of oospores in dead tops from infected fields.

It is now very easy to see how the disease has been distributed throughout this country and even the world. Nearly every farmer in the United States grows a few onions, mostly from sets. These may harbor the oospores in dry tops that cling to the little onions. Among the seed that growers of large quantities of onions use the oospores might be distributed, not in the seed themselves to be sure, but in bits of leaves and stems from infected plants. In a large onion growing district the opportunities for infection of neighboring fields are almost endless. It is almost unnecessary to point out that the most extraordinary care should be used, especially in new or uninfected lands, to prevent the introduction of any particles of dried tops from other fields.

HISTORY OF THE DISEASE.

This disease has long been known in Europe, where it is called by growers the "Onion Mildew." That it was early a common and often observed disease is evident from the following taken from the first description of the parasite (Berkley 1841). "Very common and destructive in some years, preventing the plants, which are attacked from coming to perfection." The specific name *destructor*, which Berkley applied to the parasite, would indicate that it was even at that time a very dangerous pest. No doubt it had long existed as a parasite on wild species of onions on which it is sometimes now found. The greater number of our most troublesome fungus pests have originated in this way, becoming dangerous and destructive only under the more favorable conditions afforded by a general and widespread cultivation of their host. The blight has long been known among onion growers of France and Germany as well as in England.

In 1886 the attention of the British government was called to the prevalence and destructiveness of an onion disease in the Bermuda Islands. Mr. Arthur Shipley was at once (1886) appointed to investigate the trouble. He began the work by a preliminary trip to the Canary Islands. He found two diseases very common there, which from his remarks were very evidently the blight, caused by Peronospora schleideniana, and the onion smut, caused by Urocystis cepulæ. The blight which is known there as "La Escarcha" meaning hoar frost, or as "La Ceniza," ashes, from the peculiar appearance of affected leaves is not regarded by growers as dangerous. The next year (1887 Mr. Shipley visited the Bermuda Islands. He found the disease to be the blight or onion mildew, instead of an insect disease as he had anticipated. It was decidedly less than the previous year, but still plentiful enough to cause much damage. Mr. Shipley's work was very extensive. He worked out and discussed quite fully many of the important points of the life history of the fungus. He also discussed the conditions affecting the life of the fungus and suggests several ways of combating the disease. His work is by far the most comprehensive and important that has been published up to the present time.

The early history of this onion blight in the United States is very fragmentary and indefinite. So far as I can discover, the first published reference to this disease was made in the report of the microscopist, Thos. Taylor (1872) in the Annual Report of the Department of Agriculture for that year, p. 193. Several fungi occurring on onions both saprophytic and parasitic are here figured. But both figures and descriptions are so hopelessly confused that it is not clear just what the author saw. Peronospora schleideniana is not figured. Spores of Urocystis and Macrosporium are shown. However, from among the tangle it is possible to unravel the fact that the blight did occur to a destructive degree throughout the onion growing regions of Massachusetts and Connecticut even at that date.

Apparently not until 1883 was the disease definitely recognized and described in this country. In that year Dr. William Trelease, (1884) then of the Wisconsin Experiment Station, observed the disease in that State, and described and figured it in the First Annual Report of that station, 1884. It was apparently at that time quite a destructive disease in the West. Several pages of the report together with five figures are devoted to this fungus. This report is by far the best and most complete discussion of the disease published in this country up to the present time. It seems not to have been again reported until 1889, when Dudley (1889) then of the Cornell University Agricultural Experiment Station, reported it as having been common though not very destructive in the vicinity of Ithaca during the previous year (1888). It was reported by other Experiment Station Botanists about the same time: Thaxter (1889) from Conn.; Jones (1890) from Vermont. Jones again reported it as a serious trouble among onions in the same State in 1895–96. He also spoke of it as reported from New York. It was again reported from Wisconsin by Goff (1893.) During the present year as has already been shown, it was very common throughout this State. It would appear then, judging from the reports of this disease, that it recurs with destructive effects at least about every five or six years; 1885–86, Wisconsin, Bermuda. 1888–89, New York, Conn., '90, Vt. 1895–97, Vt., New York, Wisconsin. 1902–03, New York.

COMMON NAME OF THE DISEASE.

As is naturally to be expected various names have been applied to the disease by growers in different parts of the world. Even at the present time in this State the disease is popularly known under several different names. Some of the names applied to it in other countries have already been referred to. In this country it is generally known among growers as blight. Often the terms smut and blight are both applied to it. Smut, however, is caused by quite a different fungus. The smut fungus is much like the smut of corn or oats. It attacks the bulbs more especially forming long blisters on the outer leaves of the bulb filled with a mass of black spores. It is more destructive than the blight but does not occur so generally. "Onion mould" and the "white blight" are other names that have been applied to onions affected with Peronospora schleideniana. Thaxter says it is often called "white blast." Since "blight" is the term commonly used among growers in this State we have thought it best to use this name in referring to the disease.

A SECONDARY FUNGUS—MACROSPORIUM PARASITICUM.

Growers are often concerned by the blackened appearance of the dead and dying leaves, regarding this as the cause of the trouble. It was always observed that the leaves killed or greatly weakened by *P. schleideniana* soon became black. Examinations showed this to be due to a saprophytic fungus, determined by Miyabe (1889) as *Macrosporium parasiticum* Thüm, or really only a form of *M. sarcinula*, Berk. It is nearly always found on dead and decaying leaves of onions. Wherever the Peronospora occurs this is sure to be found. It is a secondary fungus following the blight. Miyabe thinks he has shown that it is a facultative parasite and may cause a disease of living onions independent of the blight fungus. All the observations so far seem to show that it is simply a saprophyte. Growers need not be alarmed at its appearance on dead or dying tops. It should not be confused with the blackening of the bulbs due to onion smut (*Urocystis cepulæ* Frost).

OTHER DISEASES OF ONIONS OBSERVED IN 1903.

Although it is the purpose of this paper to deal chiefly with the onion blight, it may not be out of place to refer briefly to some of the other diseases of onions met with in our travels about the State. The cause of insect diseases is naturally, more generally and better understood by the average farmer than are those caused by parasitic fungi.

The onion maggot appears to have been quite destructive during the earlier part of the season in most onion districts of the State. In the onion regions about Canastota large fields were pointed out that, according to the informant, had been practically ruined by this insect. The onions in such fields were very scattered. Often entire rows had been destroyed. Those that had survived were usually large and thrifty but as these were few the crop, of course, was very short. Thrips appeared in sufficient numbers in several places to cause considerable damage. On the farm of F. A. Booths of E. Bethany, at least half of his eighteen acres of onions were very badly affected. The leaves had a whitish color due to the killing of the green tissues by these tiny insects. This, of course, greatly reduced the vitality of the leaf and hence its efficiency as a bulb builder. As the leaves grow older many of them break or bend over at some distance back from the tip. The cavity formed in the sinus of this bend affords an excellent retreat and breeding place for these tiny pests. Here they are safe from all enemies and especially from all killing mixtures that the grower may apply. No smut was met with and from what could be learned from the growers I am inclined to believe that if it occurs in this region it is very rare. Another trouble that was often observed is what is known among growers as "white tips." The leaves begin to die at the very tips becoming white and withered. This gradually extends down the leaf from one to two or three inches. Occasionally the entire leaf succumbs. In most cases a small portion of the tip dries up while the rest of the leaf remains green and healthy. Careful microscopical examination of many of these leaves showed no traces of any fungus. Even saprophytic forms usually so common on dead onion leaves were not present. Observations on this malady leads to the conclusion that it is due to wet weather or poor drainage. The worst cases observed were at Batavia and Fulton. The field of Bonney & Ware at Batavia was in the form of a long narrow strip running north and south. The south end was bordered by a large open ditch which drained the swamp and across the ditch were uncleared swamp lands covered with tall trees. This also extended along the east side of south end, thus effectually shutting off winds and preventing the early morning sun from reaching the onions. Rains had been frequent and heavy and this part of the patch was kept constantly moister than the rest. Here the white tips of the onions were conspicuous, nearly every leaf being affected. Toward the northern end they gradually disappeared. The more exposed and drier the onions were, the less were they troubled with the disease. At Fulton on the farm of W. B. Howard there were many of these white tips. Here lack of sufficient drainage appeared to be largely the cause. The better drained portions showed very few of the white tips. Better drainage and more exposure to sun and wind are obviously the remedy for this trouble.

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I wish to say that this bulletin is not intended as a technical discussion of the fungus, P. schleideniana. It is prepared primarily for the onion growers of the State and is largely the report of the field work on the disease during the past season. Several interesting points regarding the morphology, etc., of the fungus which heretofore have not been observed have been worked out and will be presented later in a technical paper.

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